

# Aviation Week & Space Technology

75 Cents

A McGraw-Hill Publication

December 17, 1962

India's Aircraft  
Industry Reacts  
To China Threat

Piasecki 16H Compound V/STOL



Project Fire to Obtain Apollo Re-entry Data



## weight / master locknuts—A VOI-SHAN IDEA IN ACTION!

In probing and solving fastener design problems, Vo-Shan puts to good service the long experience and know-how that has earned the company its pre-eminent reputation they hold in the field of quality fasteners. Weight/master locknuts are used in aircraft, military and industrial applications to offer the following:

**CONVOLUTIONS**—Flaring and flared anchor nuts, hexagonal, 12 point and various other specials for aircraft, missile, and jet engine applications.

**WEIGHT REDUCTION**—Weight savings average 30%.

**LOCKING ELEMENT**—Industry accepted double and triple winged locking device.

**MATERIALS**—Columbiar, Molybdenum, Inconel 61, B-50, Inconel-X, A-286, Aluminum, and Alloy steel.

**FINISHES**—"Dural" BAC Silver, Nickel-Zinc, Nickel-Cadmium, Cadmium, and various solid film lubricants.

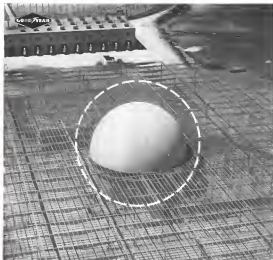
**TEMPERATURE RANGE**—-250 to 3200 degrees Fahrenheit.

As in bolts and other fastening devices, Vo-Shan supplies weight/master locknuts to satisfy needs ranging from electrical components to sophisticated structural outer space applications.

For further details on the above, or any special requirements, write for Vo-Shan's comprehensive weight/master locknut on your letterhead.



**VOI-SHAN MANUFACTURING COMPANY**  
A DIVISION OF VSI CORPORATION, 8443 Higgins Street, Cerritos City, California



## IDEA: Create the world's most wide-eyed radar antenna

In the middle of that circle is the world's largest hemisphere radar lens. Its prime advantage: Continuous, horizon-to-horizon coverage and a full 360° view—a major improvement over parabolic antennas which can "see" in only one direction at any instant. Its purpose: To sense transpired radar signals bouncing off an attacking ICBM.

Data provided by the antenna permitted computers to plot an intercept course for Nike Zeus, the Army's anti-missile missile system, which recently demonstrated the first successful intercept of an Atlas-launched ICBM target vehicle.

This radar antenna measures 100 feet in diameter and contains tens of thousands of foamed plastic tubes cov-

ered with metal particles. Yet for all its size and weight, the 1,000,000-pound lens and supporting structure reside with the precision of a fine watch. It was designed and developed by GAC—Goodyear Aircraft Corporation—part of the nationwide industrial team brought together by Bell Telephone Laboratories and Western Electric leaders by the Army's Nike Zeus system.

And radar structures are only one of GAC's many capabilities. We can also help on with advanced systems and aerospace support equipment—electronic subsystems—lightweight structures—or missile requirements. Now. Write Goodyear Aircraft Corporation, Dept. 9145X, Akron 15, Ohio, or Littlefield Park, Arizona.

LIND, DEB, AIR OR SPACE—DESIGN THAT BUILDS BETTER DEFENSE SYSTEMS

**GOODYEAR**  
GOODYEAR AIRCRAFT CORPORATION

Tungsten and its alloys  
Tantalum and its alloys  
Molybdenum and its alloys  
Columbium and its alloys  
Nickel base alloys  
Cobalt-base alloys  
Iron-base alloys  
Austenitic Stainless steels  
Ferritic-Martensitic Stainless steels  
Titanium and its alloys  
Zirconium and its alloys  
Magnesium and its alloys  
Alloy steels  
Carbon steels  
Aluminum and its alloys  
Copper and its alloys  
Thium and its alloys  
Bismuth and its alloys

When  
Part  
Integrity  
Grows  
Critical  
by  
Degrees

Whether your needs extend—higher  
operating temperatures, higher strength-to-weight  
ratios at room temperature . . . or  
increased stress rupture limits above  
1000°—you will find at Wyman-Gordon  
the outstanding experience in finding  
any material you have under  
consideration. For more than 70 years of  
collaboration with industrial and  
aerospace largest corporations, this  
experience has worked virtually every  
applicable metal and alloy—  
planning the close-to-the-forging of  
every. Operating one of the most  
completely equipped research facilities,  
devoted to advanced aerospace  
materials applications, Wyman-Gordon  
is uniquely qualified to solve any  
temperature-oriented forging problem.  
The broad range of low-working  
temperature available here ensures full  
enhancement of mechanical properties  
to meet and difficult-to-define  
refractory metals and exotic alloys.  
To give you projects the reliability  
advantages of Wyman-Gordon  
materials selection and forging  
applications counsel, contact Product  
Managers, Special Products.

IT'S TIME  
TO CALL UPON  
INDUSTRY'S BROADEST  
MATERIALS FORGING  
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is part of American International Corp. Division of  
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**GORDON**

Specialty development, fabrication and other services directly  
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FORT WORTH TEXAS PASADENA CALIFORNIA

## AEROSPACE CALENDAR

- Dec. 16-Helicopter Physics Meeting, Aeronautics Society and American Society for Advancement of Science, Philadelphia, Pa.
- Dec. 17-American Automobile Society Symposium on Scientific Services: Materials and Design, Princeton, N.J.
- Dec. 14-15-Villanova and Schuylkill Conference, Institute of Radio Engineers, Clarendon Hall, Philadelphia, Pa.
- Dec. 19-20-10th Annual Convention, 14th regular Ann. of America, Cuban Missile, Miami, Fla.
- Dec. 14-15-American Engineering Congress and Exposition, Society of Automotive Engineers, Cobo Hall, Detroit, Mich.
- Dec. 14-15-North Atlantic Meeting, American Institute of Aeronautics, Seattle, Wash.
- Dec. 19-22-Annual Meeting, Ann. of Local Transport, AIAA, National Aeronautics Club, Washington, D.C.
- Dec. 21-23-The Annual Meeting (including Wright Brothers Lecture), Institute of the Aerospace Sciences, Hotel Astor, New York, N.Y.
- Dec. 21-24-4th Annual Meeting, American Meteorological Society, New York, N.Y.
- Dec. 22-24-Fifth Annual Symposium on Reliability and Quality Control, American Public Hotel, San Francisco, Calif.
- Dec. 25-Fifth Annual Active Aeronautics Best Service Symposium, International Inst., Washington, D.C.
- Dec. 30-Feb. 1-Fourth Annual Solid State (Continued on page 7)

## AVIATION WEEK and Space Technology

December 17, 1962  
Vol. 37, No. 35

Aviation Week and Space Technology is a special issue of AVIATION WEEK and SPACE TECHNOLOGY, published by McGraw-Hill. It is a comprehensive source of information on the latest developments in aviation and space technology. The issue is published annually and is a must-read for anyone interested in the field. It contains a wealth of information, including articles, reports, and data, all of which are presented in a clear and concise manner. The issue is a valuable resource for anyone working in the field of aviation and space technology.

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## NEW! Solid State time/delay/relays



...with traditional AGASTAT® reliability!

Now available . . . solid state time/delay/relays with the accuracy essential for critical missile and computer applications! These new AGASTAT relays are the result of over 25 years' time delay engineering and manufacturing experience . . . specialized experience which has made AGASTAT the standard of reliability throughout industry.

**Advanced design** combines specially selected semiconductor and other components in a "sandwich" configuration. Results: the standard models meet flexibility, uniformity, and rapid delivery of "customer" produced prototypes. The solid state AGASTAT is hermetically sealed . . . resistant to vibration and shock. Special circuitry protects against input polarity reversal, provides immunity to voltage transients and continuously modified inputs.

**What are your requirements?** These solid state relays are only 1 1/2" sq. available in one standard type, with delay on pull-in or drop-out, timing ranges from milliseconds to hours, on pull-in or drop-out. Operation—30 Hz. to 500 Hz., load capacity to 5 amperes. Whole Dept. 51-112 for data sheets. Or ask for a quotation on your special application requirements.

**AGASTAT TIMING INSTRUMENTS**  
CLASSIC STEP UNIT CORPORATION OF AMERICA  
ELIZABETH DIVISION • ELIZABETH, NEW JERSEY

JV CANADA: BENTON HARRIS LTD. 10 BOWEN ST. TORONTO 16, ONTARIO, CANADA



# KNOW YOUR ALLOY STEELS . . .

*This is one of a series of advertisements dealing with those few alloy steel steels. Through much of the information is elementary, we believe it will be of interest to many in this field, including some of those engineers who may find it useful to receive background from time to time.*

## Cold-Finishing of Alloy Steel Bars: Grinding and Polishing

Grinding and polishing of cold-drawn or turned alloy steel bars is the concluding discussion on the subject of cold-finishing. In the processes of turning and polishing, and grinding and polishing (both of which require removal of surface metal), the surface finish of the bar, as well as their dimensional accuracy and alignment, are improved. But the ultimate in quality of bright, smooth surface finish and accuracy is produced by grinding and polishing of either cold-drawn bars or turned bars up to 4-in. diam, inclusive.

### GRINDING AND POLISHING

Sizes up to and including 4-in. diam, are generally confined to conical-cylindrical grinders. Larger sizes are ground on centers. A centerless grinder includes a grinding wheel, a regulating wheel for applying pressure against the bar, and a work-rest blade which both supports the bar and guides it between the wheel spacing. Automatic feed of the whole length of the bar is accomplished because the regulating wheel is set at an angle of inclination with respect to the grinding wheel, and thus within this system the bar rotates and feeds during grinding. The bar is then polished to a mirror-like finish by passing through straightening rolls.

Both processes of turning and polishing, and grinding and polishing, are applicable to normalized, annealed, or heat-treated carbon and alloy bars. These operations do not materially affect the mechanical properties. For this reason, the end product can be machined asymmetrically, with little or no tendency to warp.

Tactical Service Bethlehem metallurgists have given long study to specifications with respect to chemical composition, grain size, hardenability, and the machinability of cold-drawn alloyed bars. If you would like additional information on cold-drawn products, or alloy steels, our metallurgists will gladly give you all possible help, without cost or obligation.

When you order alloy steels, remember that Bethlehem offers the full range of AISI standard grades, as well as tool steels, special-analysis steels, and all hot-rolled carbon grades.

*This series of alloy steel advertisements is now available as a compact booklet, "Quick Facts about Alloy Steels." If you would like a free copy, please address your request to Advertising Department, Bethlehem Steel Company, Bethlehem, Pa.*



BETHELEHEM STEEL COMPANY, BETHELEHEM, PA.

*Equal Opportunity Employer*

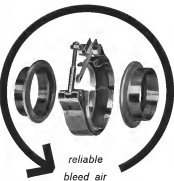
**BETHELEHEM STEEL**



## AEROSPACE CALENDAR

(Continued from page 7)

- Apr. 15-16**—Aerospace Research Conference, American Rocket Society and American Society of Mechanical Engineers, Naval Ordnance Laboratory, White Oak, Md.
- Apr. 17-19**—International Nonlinear Mechanics Conference, Sheraton Hotel, Washington, D.C.
- Apr. 19-18**—Southwestern Conference and Electronic Show, Institute of Radio Engineers, Dallas Mountain Auditorium, Dallas, Tex.
- Apr. 17-18**—Technical Meeting, Nuclear Materials for Space Applications, American Nuclear Society, Northbrook Hotel, Glenview, Ill.
- Apr. 22-23**—Annual Meeting, National Aerospace Sciences Area, Washington, D.C.
- Apr. 22-24**—Second Annual Space Flight Symposium, Institute of the Aerospace Sciences in cooperation with NASA and AFSC, Dallas, Tex.
- Apr. 22-24**—Third Annual Sea Days Symposium for Biomedical Engineering, Del Webb's Conference, San Diego, Calif.
- Apr. 24-26**—Seventh Region Technical Conference, IRT, San Diego, Calif.
- Apr. 26-28**—22nd Annual National Conference, Society of Automotive Weight Engineers, Sheraton-Jefferson Hotel, St. Louis, Mo.
- Apr. 29**—19th Annual Conference, Society of Photographic Scientists and Engineers, Arlington Hotel, Atlantic City, N.J.
- Apr. 29-30**—Annual Research Office, Aerospace Research Office.
- May 13-18**—Annual National Fusion, American Helicopter Society, Sheraton Park Hotel, Washington, D.C.
- May 18**—Southwestern Conference, American Rocket Society and Aerospace Medical Assn., Los Angeles, Calif.
- May 18-19**—Fourth National Symposium on Human Factors in Electronics, Institute of Radio Engineers, Marriott Twin Bridges Hotel, Washington, D.C.
- May 18-19**—Aerospace Reliability and Maintainability Meeting, Institute of the Aerospace Sciences, Washington, D.C.
- May 19**—Electronic Components Guide, Institute of Radio Engineers, Marriott Twin Bridges Hotel, Washington, D.C.
- May 19-19**—National Aerospace Electronics Conference, Institute of Radio Engineers, Dayton, Ohio.
- May 19-19**—Government Council, Flight Physics Second National Symposium in Annapolis, Annapolis, Md.
- May 20-22**—National Symposium on Microelectronics and Technology, Institute of Radio Engineers, Hyattsville Hotel, Silver Spring, Md.
- May 20-22**—National Telecommunications Conference, Silver Spring, Md.
- May 21-23**—Spring Joint Computer Conference, American Federation of Information Processing Societies, Cobo Hall, Detroit, Mich.
- May 21-23**—Seventh National Conference on Product Engineering & Production, Institute of Radio Engineers, Continental Hotel, Cambridge, Mass.
- June 2-16**—24th French International Air Show, Le Bourget, Paris, France.



## duct couplings

If your concern includes the reliability of pneumatic duct couplings in aerospace applications, take a look at the Janitrol line. Janitrol bleed air couplings have industry wide acceptance because they provide virtually 100% sealing with low net torque, lower stresses mean higher reliability. Absolutely no gaskets are required. For the ultimate in safety specify Duct Lock® couplings that seal even if the bolt is disconnected. Janitrol clamps, flanges, duct supports and other hardware are used in the 707, 880, 990, DC-8, F-105D, F4H, F-110, F8U and other high performance aircraft.

Janitrol standard and Duct Lock couplings are described in our \$6-page catalog, a valuable reference for designers.

Janitrol also designs and builds couplings for special applications—extreme high temperature and pressure, and cryogenics. Request catalog JA 142 from Janitrol Aero Division of Midland-Ross Corporation, 4200 Surface Road, Columbus 4, Ohio.



A Division of Midland-Ross Corporation



The 272 Series 2-A Atmospheric Storeroom (272-AS) being mated to the Space Shuttle Challenger in the Vehicle Assembly Building at NASA's Goddard Space Flight Center.

## "WORKHORSE" FOR GODDARD'S ENVIRONMENTAL TESTING

The Goddard "8 by 8" (8 ft. in diameter and 8 ft. long) horizontal test chamber is one of the key elements in the spacecraft testing program at NASA's Goddard Space Flight Center, Greenbelt, Maryland.

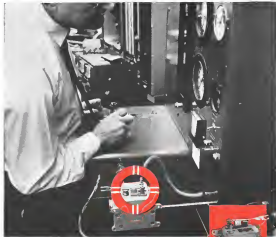
The Stokes-designed and Stokes-built thermal-vacuum vault was the first large space simulation facility installed at Goddard for testing aerospace vehicles under the full range of thermal and vacuum conditions, and is the largest presently in use there. It has a vacuum capability of  $1 \times 10^{-7}$  Torr (300-mile altitude) under full load conditions, and is equipped with a heat transfer system capable of handling radiant wall temperatures from  $-60^{\circ}\text{C}$  to  $100^{\circ}\text{C}$ .

Goddard's "8 by 8" will continue to serve in the Space Flight Center's highly successful reliability testing program until the larger test and evaluation laboratories now under construction go into service early in 1982. Major space test chambers at this facility, which is expected to set the next advanced standards for spacecraft check-out, are two 35 ft. diameter, 60 ft. high thermal-vacuum environmental simulators. Stokes was selected as the prime contractor to NASA for complete vacuum and cryogenic systems for these large chambers.

We welcome your inquiries regarding our capabilities and facilities for designing, fabricating, and erecting simulation facilities and in advance of the state-of-the-art, or any portion of a simulation project requiring high-vacuum and cryogenic systems. Space Systems Department, P. O. Box 10000, 3000 N. 10th St., Philadelphia, PA 19104.

STOKES INTERNATIONAL: PHILADELPHIA • TORONTO • LONDON

**STOKES**



## The **LIFEGUARD** of the future on schedule today at SCOTT

Passenger safety is a never-ending challenge at Scott. The Aerospace Passenger Oxygen Flow-Control Unit (Composite Regulator), undergoing exhaustive tests at Scott research laboratories, has been selected as standard equipment on the Boeing 747 jet. It automatically activates and controls oxygen flow to the passenger emergency oxygen system, replacing as many as seven previously required components including pressure reduction, automatic turn-on and altitude flow control, activation surge, and turn-off.

The new Scott Composite Regulator is automatically activated at cabin altitudes of approximately 14,000 feet, and turns off again automatically at cabin altitudes of between 8,000 and 10,000 feet. The unit can be manually reset to "off" position at any altitude in between, while still retaining the auto-

mate features. As an added safety feature, the Regulator supplies a momentary surge immediately after activation of approximately 80 psi, lasting about 10 seconds. This assures immediate filling and pressurization of the distribution system and positive activation of mask presentation devices. After this initial surge, pressure is maintained at required levels, automatically controlled in response to system flow requirements and changing cabin pressure.

In addition to its many versatile features, the Scott Composite Regulator offers significant advantages in reduced weight, better efficiency, lower maintenance costs, and increased configuration flexibility.

For more information on the Scott Composite Regulator and how it can help you solve aerospace design and engineering problems write, phone, or wire:



**SCOTT AVIATION CORPORATION** SUITE 400, LANCASTER, NEW YORK

Export: Southern Oxygen Company, 2 West 57th Street, New York 20, New York. West Coast Office: Fuller-Nelson Bldg.,

1572 Wilshire Blvd., Suite 200, Culver City, California. Great Britain Office: The Henry Noble Company, Ltd.

New development from HONEYWELL!



This new HONEYWELL PHOTOCONDUCTIVE INFRARED DETECTOR offers you advanced capabilities for pinpoint photo reconnaissance. New discovered in responsiveness and detectability enable this unique infrared antenna detector to produce infrared maps of highest resolution using present systems.

Available now in production quantities this new IR Detector features a ground sapphire window, and offers performance characteristics and design flexibility previously unavailable to photo reconnaissance systems designers. Standard model contains integral cooling coil.

Large Dewar designs are also available if desired. For details, contact your nearest Honeywell representative or Minneapolis Honeywell, 1400 Soldiers Field Road, Boston 35, Mass.

# Honeywell

**H** ENGINEERS & SCIENTISTS: Explore new professional opportunities. Write Honeywell at address shown above.

WINDTUNNEL  
AERODYNAMICS

ELECTRONIC  
NAVIGATION

NAVIGATIONAL  
SYSTEMS

FLEX WING  
VEHICLES

SPACE  
STRUCTURES

APPROPRIATE  
COMPONENTS

RADAR  
ALTIMETERS

ADVANCED  
OPTICAL INSTRUMENTS



The solution to many space  
age problems lies within

## Ryan's spectrum of capabilities

These notable breakthroughs by Ryan scientist-engineer teams, demonstrate proven capability to create the necessary technology and to manage every phase of new, complex systems.

- Design, build and fly the world's first jet VTOL airplane. Then apply over three million man-hours of VTOL experience to creating such modern aircraft as the Army's XV-5A Jet Fan aircraft.
- Take a concept like the flexible wing and develop a successful test bed vehicle with broad applications—the Ryan Flex Wing.
- Pioneer the C-W Doppler principle into world leadership in the production of electronic navigation systems for all types of aircraft now flying or proposed.
- Develop complete jet target systems like the famed Ryan Free-lance—most widely used target jet in the free world.
- Design and fabricate radar altimeters, precision antennas and space structures for such advanced space vehicles as Mariner II, Solara, Surveyor.

From advanced electronics to the fabrication of space age metal, Ryan is prepared to assist government and industry in studies, design, development, production, and the field support of complete operational systems and equipment.

RYAN AERONAUTICAL COMPANY, SAN DIEGO, CALIFORNIA

**RYAN**  
AERONAUTICAL COMPANY

How many ways can **TRANS-SONICS, INC.** serve you?



## VERSATILITY

The unit above has been used as a raw element indicator, for the most pronounced of cryogenic leaks, and as the basic sensor in a radiometric analysis recorder.

The unit above is an infrared A/P transducer for Trans-Sonics, Inc. Devcon by uncooled 28 volt, it produces a 0.5 volt output over a maximum range of 0.30 inch Hg.

It is a straightforward and versatile device.

Not all Trans-Sonics' designs are as versatile — we design and build units for specific needs. Our versatility comes in the technologies that we use, and the ability to solve no problem. Devcon digital readout, piezoelectric force, and amplification devices, and solid-state self-balancing bridges have all been employed in the design of Trans-Sonics' measurement and systems.

Transducers and systems for the measurement of level, temperature, pressure, and flow — represent the versatility of the custom-built engineering talent in Trans-Sonics, Inc. (Spartanburg Plant of Leach Devcon, Inc.)

For a full line of measurements...  
**TRANS-SONICS, INC.**  
2001 S.W. 10th Ave.  
LEXINGTON, VA, HARRISBURG, PA

## nothing but talk...talk...talk...

LEACH SATELLITE RECORDER/REPRODUCERS are now in orbit storing lots and lots and lots of data... playing back when and where needed.

The unit shown here records on 1/4-inch Mylar base magnetic tape up to 210 minutes at 1.8 ips... transmits back to earth in 8.07 minutes. As it transmits, it erases itself and records all over again.

Seven pounds light and seven inches narrow, this Leach Satellite Recorder/Reproducer has taken the rockiest launch

in stride, works in temperatures from -30°F to 130°F with an average power consumption of only 4 watts.

If you're in the satellite making business, you should make it your business to know more about this recorder/reproducer and how it can be adapted to your needs. You can know, too. Just send a line to Leach. You will get complete specs on this specially engineered recorder as well as other high environmental tape recorders — in the return mail.



**LEACH**  
CORPORATION

20430 Sycamore Road, San Jose, Calif.  
Export — Leach International S.A.



We are heavily involved in exotic instrumentation.



A case in point is cryogenics.

In modern, fully equipped cryogenic development laboratories, a unique combination of Bendi experience is available to help meet your cryogenic instrumentation requirements. Our experience includes 11 years—liquid hydrogen, 23 years—liquid oxygen, and 42 years—precision instrumentation.

Precision: one of your requirements is the precise measurement of temperature between 20°K and 400°K.

with digital readout. We can meet this and other cryogenic instrumentation requirements.

In addition to cryogenics, we are also active in the development of life support systems (both aircraft and manned missiles), propellant measurement and control, precision speed/surge electronics.

Tell us what you are working on. Tell us what you need. Let us help you. Write us in Evansport, Iowa, Dept. A.P.R.

Pioneer-Central Division



## All Titan I's are operational

The entire force of Titan I intercontinental ballistic missiles is now operational. Six squadrons.

This achievement met a schedule laid down by the Air Force in 1959, calling on Martin Company to design, fabricate, test and deliver a reliable, operational Titan system.

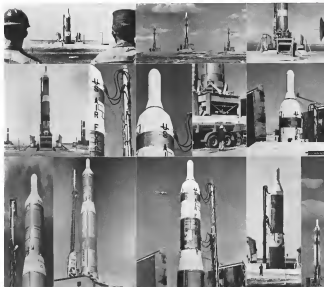
Martin was also called upon to manage the simultaneous development and completion of steel and concrete underground sites to protect the missiles

and hold them ready for firing against targets more than 6,300 statute miles away.

The missiles were ready and this most complex and difficult construction project in history was finished in late summer, 1962—as scheduled.

Already well on the way toward completion and operational status are six more hard-based squadrons for Titan II, more powerful, faster-reacting Air Force ICBM.

**MARTIN** MARTIN COMPANY



# Air Force adds deadly new striking power with advanced Raytheon Sparrow III missile

Already the prime air-to-air missile of the U.S. Navy, Raytheon's advanced Sparrow III, has now been selected by the U.S. Air Force as armament for its F-4C Phantom II fighter.

Since Sparrow III's become operational in 1958, Raytheon has steadily increased the range, speed and altitude capabilities of this deadly defensive weapon, keeping pace with the constantly improved performance of our aerial and "harder" jet fighters.

As with earlier systems, the improved Sparrow III employs a unique target seeker which permits one fighter plus maximum attack flexibility under combat conditions. One located in the target, the other guides the missile to intercept, despite evasive maneuvers, constantly refining its aim as it closes on the enemy aircraft.

The Sparrow III weapons system is another example of Raytheon electronics and systems management skills at

work—on behalf of business, industry, science, and defense. Raytheon Company, Lexington, Mass.

RAYTHEON



Volume 77  
Number 28

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JOURNAL CONTENTS

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## Aviation Week & Space Technology

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### EDITORIAL

The Skybolt Missile 31

COVER: Persuade SAM helicopter lowers rate country troops in Philadelphia International Airport during recent fight with U.S. Air Force. Note unusual shoulder strap on tail, which provides identification in case of confusion with other landing and propulsion during crash landing gear is retracted, and wings and rotor may be folded.

COVER: Skybolt missile. 31—Editorial; 32—Editorial; 33—Editorial; 34—Editorial; 35—Editorial; 36—Editorial; 37—Editorial; 38—Editorial; 39—Editorial; 40—Editorial; 41—Editorial; 42—Editorial; 43—Editorial; 44—Editorial; 45—Editorial; 46—Editorial; 47—Editorial; 48—Editorial; 49—Editorial; 50—Editorial; 51—Editorial; 52—Editorial; 53—Editorial; 54—Editorial; 55—Editorial; 56—Editorial; 57—Editorial; 58—Editorial; 59—Editorial; 60—Editorial; 61—Editorial; 62—Editorial; 63—Editorial; 64—Editorial; 65—Editorial; 66—Editorial; 67—Editorial; 68—Editorial; 69—Editorial; 70—Editorial; 71—Editorial; 72—Editorial; 73—Editorial; 74—Editorial; 75—Editorial; 76—Editorial; 77—Editorial; 78—Editorial; 79—Editorial; 80—Editorial; 81—Editorial; 82—Editorial; 83—Editorial; 84—Editorial; 85—Editorial; 86—Editorial; 87—Editorial; 88—Editorial; 89—Editorial; 90—Editorial; 91—Editorial; 92—Editorial; 93—Editorial; 94—Editorial; 95—Editorial; 96—Editorial; 97—Editorial; 98—Editorial; 99—Editorial; 100—Editorial; 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## EDITORIAL

### The Skybolt Muddle

The recent international muddle over the Douglas Skybolt air-launched ballistic missile is typical of the confusion between technology and politics that forces the developmental commitment of any new weapon system. Fate of the program now apparently can only be decided at the top Anglo-American level at the coming Nassau meeting of President Kennedy and British Prime Minister Macmillan (see p. 26).

In the political portion of the Skybolt commitment, there is no doubt that the British are absolutely dependent on the weapons for the future effectiveness of their nuclear deterrent force. Their only effective long-range nuclear deterrent system for the foreseeable future will be the Avro Vulcan bomber armed with a pair of Skybolt missiles. The U.S.-financed Thor IRBM already are being removed from their Royal Air Force pads in Britain, the de Havilland Blue Streak IRBM development program has been stopped short of production, the British Avrocar Cap. Blue Water MBKM has been cancelled. All of these actions were taken because of British confidence that the U.S. would continue development of Skybolt to its operational phase, and that it would enter the RAF inventory as the prime nuclear delivery system for Britain's strategic deterrent force. Without the Skybolt, the Royal Air Force and Britain will face the future with no weapon more effective than the 100 lb. single Wire Steel as its nuclear mainstay now going into service with the Vulcan and Victor bombers.

### Britain's Suspicions

That there is a strong suspicion in London that the U.S. effort to wash out the Skybolt is a thinly disguised attempt to blackball Britain out of the nuclear weapons club, despite President Kennedy's recent assurance to the contrary. From the other side of the Atlantic it appears that the Skybolt plan is successful in driving Britain out of the nuclear deterrent group, thus it will be even more feasible to dispose the French effort to build its nuclear delivery system based on the Mirage 4, Etendard and other future possibilities. Speaking for the Kennedy Administration, Defense Secretary McNamara has indicated disapproval of other bidders than their own nuclear deterrent forces, although he approved French purchase of the Boeing D-195 bombers seems, to make the Mirage 4 striking force effective.

If Britain and France are forced out of the nuclear deterrent business, it would polarize international relations between Washington and Moscow, leaving Chairman Khrushchev and President Kennedy free to negotiate without interference by troublesome allies in both blocs.

These nasty thoughts are one reason the Skybolt issue has far-reaching international implications that extend beyond any budgetary or technical problems. If it were felt by the British and French are unfounded, there still remains the basic question of U.S. integrity in relation to its allies. U.S. is already on record as having

polled the technical rug from under French IRBM development, although no prior assurance were in violation. If a new scuttled Skybolt and the British deterrent after repeated firm promises to deliver, it will be sad to watch the decoupling of U.S. stick on the NATO house.

Perhaps the least political view taken of the current Skybolt muddle is that Mr. McNamara simply wants to raise the British ante in the Skybolt program for the rather meager \$20 million now pledged to ease the Fiscal 1964 budgetary problems, which are growing more formidable with each passing month.

### Aimless Development

On the technical side, it has been a long-time military among planners of the Skybolt program has the main argument of such a supposedly critical international development program was allowed to drift in such aimless fashion for as long by all responsible agencies concerned. Much has been accomplished to remedy these ailments recently, but too developmental time can never be regained nor can technical trouble ever be fully removed after such cavalier treatment. However, despite this now-worn history in the Skybolt story, it is hard to substantiate all of the technical gloom being cast over the program from without. To pass technical judgment on the Skybolt program on the basis of its first few test firings would be rather naive, and instead of finding a convenient excuse to support budgetary or political decisions, rather than any responsible technical judgment.

There are many competent engineers working on Skybolt who would challenge President Kennedy's recent statement that this weapon is "in a sense, the kind of engineering that's been beyond us." To him, in the technical sphere on Skybolt because its first few test firings were not completely successful would be as foolish as to curtail Minuteman ICBM deployment because of the recent failures in test firings at both Cape Canaveral and Vandenberg AFB. There are related formidable technical problems involved in perfecting an air-launched ballistic missile as an operational, reliable weapon, but they are not much less significant than those already encountered successfully in developing the first generation ICBMs, and there is no real basis for believing they cannot be solved.

There can be some perfectly valid reasons for phasing out Skybolt development and substituting an introduction into the Strategic Air Command and Royal Air Force bomber fleets, but they are not anything to cause President Kennedy or Mr. McNamara's discussion of the problem to date that would qualify as this category. We expect that British Prime Minister Macmillan and the legislative bodies of both countries concerned will demand considerable more discussion on these points before they support any final decision on Skybolt.

—Robert Riota





# Skybolt's Fate Up to Kennedy, Macmillan

British protest bitterly at talk of cancellation; President cites difficulties of developing missile system.

Fate of the Skybolt air-launched ballistic missile program remained undecided despite Britain's bitter protest against the threatened cancellation of the program and President Kennedy's assertion that its development requires "the kind of engineering that I have never seen."

The President said last week that no final decision would be made on Skybolt until after he meets with British Prime Minister Harold Macmillan at Nassau on Dec. 19-21.

Possibility that the Skybolt program might be canceled was first disclosed by *American Week & Space Technology* on Nov. 26 (p. 27). Defense Secretary Robert S. McNamara told British Defense Minister Peter Thorneycroft in London last week that the Skybolt program was under review in the Defense Dept.

Increased Russian anti-missile capabilities and conventional missile studies at the Boeing H-42 Skybolt plant in Everett, Wash., have virtually convinced Defense Dept. planners that increasing the number of Minuteman solid-propellant rockets, mental ballistic missile would provide a better solution for the future in which Skybolt would have been operational.

President Kennedy said Britain would continue to play a significant role as a nuclear power," even if the Skybolt is canceled. He said "the problem with the Skybolt is that it is the most sophisticated weapons imaginable. To fire a missile from a plane moving at high speed to the point of impact in 600 sec. requires the most advanced engineering, and, of course, it is very costly, very expensive, the kind of engineering that I have never seen."

"We put a half a billion dollars into it already. To completely, the other way, might cost up to two billion dollars, so we would want, maybe require \$2.5 billion. The fact that we have not been successful in that time is the question of how much it is worth to the British and possibly to get on that level of money when we have competing claims for our available funds."

On his arrival in England, Mr. Macmillan said "it is not correct that the Skybolt has threatened that we have failed and program ends have already started. Negotiations, no have continued to refer funds, full support the program and nearly \$500 million have been referred to it. In 1961 and previous years, no delivery has been achieved on the program for fiscal 1962."

British response to the possibility the U.S. might drop or curtail Skybolt was vehement. Political leaders condemned the U.S. and a bill was proposed in the House of Commons calling for removal of the Polaris submarine base at

Douglas Aircraft Co. was awarded a contract in 1959 to develop the 1,000-n.-m., solid-propellant rocket for the Air Force. In 1960, then President Eisenhower and Prime Minister Macmillan agreed on a joint-funded program in which Britain was to invest about \$20 million. The cost to the U.S. with revisions for an expanded program, is now estimated at about \$2.5 billion. President Kennedy said that \$900 million has been spent on the program so far.

British government is extremely opposed over the fate of Skybolt, because that country's nuclear posture depends on equipping Area Veterans and Hunter-Pigeon nuclear bombers with the weapon. Skybolt became Britain's sole hope for a powerful nuclear strike force after the Black BBRM missile and the Blue Whale nuclear cruise missile, which was canceled (AW Jan. 29, p. 14). Placement of the Royal Air Force Thor BBRMs and cancellation of Skybolt would leave Britain with only 100 air-launched Blue Streak air-to-ground rockets. Secretary of Defense Kennedy and Macmillan did not clarify the performance record of Skybolt. Air Force proponents claimed the program is well within the state of the art, that it has been partially successful already and if not built was only a week behind the schedule set more than two years ago. Defense Dept. opponents say Skybolt requires a few complex problems to be solved, one that is probably too complex and delicate for successful operation from the B-57 bomber.

Those who are familiar with the flight test program contend that the problems encountered are no more serious than those experienced by the Thor, Atlas or Titan development programs. Mis-factories, they say, have been found and with time exception, no test flight has highlighted the program's difficulties. They cite the losses of the flights:

• **First flight, Aug. 19, 1962**, was cited about 95% successful after a clean drop from the B-57H, the missile's first stage ignited and burned properly. This was the primary objective of the flight. Second stage igniter failed to set off the stage's solid propellant and the ascender, objective was not met.

• **Second flight, June 29, 1962**, was a failure. Igniters in both stages failed. Igniter solvent for both stages was required in two trials to provide longer, better burning.

• **Third flight, Sept. 13, 1962**, failed when the program was prematurely terminated September 13, first second stage igniter failed. This flight had ignited 100 sec. program was terminated and ignition of the second stage about 1

sec. after separation and according to a reliable source, attempted to correct end-over-end banking at second stage.

• **Fourth flight, Sept. 25, 1962**, was resumed after fourth after second stage ignition when the program premature terminated. Fourth flight, Sept. 25, 1962, was resumed after fourth after second stage ignition when the program premature terminated. Fourth flight, Sept. 25, 1962, was resumed after fourth after second stage ignition when the program premature terminated.

• **Fifth flight, Nov. 28, 1962**, ended prematurely when the flight control system failed on both stages. The first stage system drove four centrifuge-like arms around the base of the tank, the second stage system drove a gas-lift-mounted nozzle. Both independent systems apparently failed in similar fashion, since the Skybolt flew a descending spiral into the ocean. Ignition, burning and separation of the stages was considered successful.

The last test flight was the first test of the Navy's new tactical guidance system, which replaced the older guidance system used on the first four flights. Performance of the Navy's system was described as "near perfect" during this device launch in which it trailed more than 10 min.

Early stage status of Skybolt has caused considerable concern in some flights, but not all together on the same flight according to one source. The source believes that problems are concentrated on the first four flights can be solved by thought forward engineering and do not represent state-of-the-art deficiencies.

Some Defense Dept. officials who question the wisdom of continuing the Skybolt program point to these specific problems:

• **Successful operational use of Skybolt** requires precise launch point of the missile. To achieve the level of precision, Polaris submarine can serve as the most accurate launch point, a dual delivery capability, release navigation device and other equipment—far too expensive for a B-57.

• **It is expensive to know the accuracy of the vehicle now generally.** This is difficult on now moving platforms and increases with vehicle speed and target location.

• **Associated components on Skybolt** are subject to bumps and shocks on takeoff, turbulence and other risks to which structural component on a Polaris or Minuteman are not subject.

Political exploration of possible cancellations of the Skybolt program appear to be as important as the technical considerations. The U.S. agreement with Britain provides for development of the missile by Britain, should the U.S. cancel the program.



HARWOOD MINUTEMAN LAUNCH SITE leaves little visible to view near Malmstrom AFB. Concoats only at the site in place and sides away from the system to open the site for a launch. Also buried adjacent to the site is the command-and-control support room. Five towers around the site comprise an "eye-type" security system.

## First 2 Minuteman Flights Turned Over to SAC at Malmstrom AFB

Gen. Felt, Minuteman-First two Minuteman SACs ICBM flights officially

Gen. Felt, Minuteman-First two Minuteman SACs ICBM flights officially turned over to Strategic Air Command at Malmstrom AFB here last week. Air Force Systems Command, more than a month after some of these weapons had been on alert during the Cuban crisis.

Flights included the Alpha and Beta units—10 missiles each—of the 34th Strategic Missile Squadron, 34th Strategic Missile Wing, which is based at Malmstrom AFB. Malmstrom wing is scheduled to be completely operational with a full complement of 150 missiles in next summer. Air Force experts in receiving the missiles at the rate of one per day in the next future.

Additional of first operational Minuteman flights at Malmstrom Air Force Base, Minuteman SACs ICBM flights will include all D-1 and E-1 models of Atlas and all Titan II ICBMs. Minuteman unit's stage cost was given at just over \$1 million, including service and other allocations for ground support equipment and launch control center based on the north of the total for the Minuteman complex.

Minuteman unit cost is substantially less than its implied Atlas or Titan, but the workload is less than half Atlas unit, and a smaller fraction of the Titan unit.

The 34th Wing at Malmstrom is also the host for the 490th Strategic Missile Squadron, each of which

includes five launch control facilities (LCF).

Each LCF controls 10 missile launch facilities which are scattered throughout the launch control and command site. In a 4-in. launch control, concentrated communications cable, launch facility is only in connection to at least one other launch facility, providing a redundant communications link to the launch control center.

Air Force has moved funding for 800 Minuteman missiles and has designated four sites into a before a complete launch. SACs ICBM flights will include all D-1 and E-1 models of Atlas and all Titan II ICBMs. Minuteman unit's stage cost was given at just over \$1 million, including service and other allocations for ground support equipment and launch control center based on the north of the total for the Minuteman complex.

### Minuteman Failure

Minuteman ICBM launched from Vandenberg AFB last week in a Strategic Air Command test launch mission blow up along its trajectory about 30 sec. after launch. This was the seventh consecutive failure of the Minuteman missile at Vandenberg AFB since launch. Minuteman wing system was based on SAC officials last week.

# Rover Funds Depend on Kiwi Performance

By George C. Wilson

Washington—President Kennedy's well-known use with the Rover nuclear model development program will not have about as great a role in funding other tests of the Kiwi reactor by the Navy and the Air Force, the Atomic Energy Commission and the space agency.

The President received his decision after meeting the Los Alamos, N.M., Scientific Laboratory, and Nevada Nuclear Reactor Development Station to see the Kiwi reactor. He was told that the Kiwi reactor is a gas-cooled, fast-neutron reactor, which is not yet in the final design stage. It is not yet in the final design stage.

The two agencies want \$150 million for Rover in fiscal 1964, compared with this year's total of \$173.5 million. Although the Budget Bureau has recommended cutting the figure to \$130 million, and President Kennedy's statement last week indicated it is not yet in the final design stage, the Kiwi reactor is not yet in the final design stage. However, he could use the Kiwi reactor in testing Cereus for supplemental funds for Rover.

Thus the funding was a result.

## Kennedy Lands SAC for Crisis Performance

Orlando, Fla.—Nikola Klench, recently presented a special light safety program to the Strategic Air Command for his actions after the Cuban crisis, which he called "a unique accomplishment in the history of aviation."

The presentation was made to Gen. Thomas S. Power, SAC, Command-in-Chief, Strategic Air Command, at Orlando, Fla. The presentation was made to Gen. Thomas S. Power, SAC, Command-in-Chief, Strategic Air Command, at Orlando, Fla.

The President declared that during the crisis, SAC members and leaders have 2,000 members, which required 41,342 additional hours of flight. Under contract with the Air Force, SAC members and leaders have 2,000 members, which required 41,342 additional hours of flight. Under contract with the Air Force, SAC members and leaders have 2,000 members, which required 41,342 additional hours of flight.

The President pointed out that all the air force test units were flown without a single mishap. "This extraordinary achievement reflects the intense efforts of SAC members and staff in the Strategic Air Command in promoting flight safety."

Gen. Power said that SAC on Oct. 4 began "an intensive program of high altitude reconnaissance missions over Cuba. Coverage showed some areas that had not been seen before. This was the first photographic evidence of the nature of the Cuban air force, which was not seen before."

President Kennedy said that SAC members and staff in the Strategic Air Command, which was the first photographic evidence of the nature of the Cuban air force, which was not seen before. President Kennedy said that SAC members and staff in the Strategic Air Command, which was the first photographic evidence of the nature of the Cuban air force, which was not seen before.

It was also declared that an order of President Kennedy: SAC was on 100th ground after the Cuban crisis and is currently on 100th ground after the Cuban crisis. It was also declared that an order of President Kennedy: SAC was on 100th ground after the Cuban crisis and is currently on 100th ground after the Cuban crisis.

will determine how soon the nuclear reactor will be assigned a major role in the national space program. Leaders of an accelerated program need to be old B. F. Fungo, manager of the past AEC-NASA Space Nuclear Program Office, noted the nuclear reactor could be flight tested in early 1965 if given about \$1 billion before now and that Other Kennedy Administration officials—notably Harold Brown, Director of Defense Research and Engineering, and James B. Watson, the President's scientific advisor, claim that the Kiwi reactor is not yet in the final design stage. It is not yet in the final design stage.

President Kennedy, tonight along with Gen. Power, and Brown at the Los Alamos laboratory Dec. 7 and discussed the Kiwi reactor. It was also discussed the Kiwi reactor. It was also discussed the Kiwi reactor. It was also discussed the Kiwi reactor.

During the recent briefing, the President was accompanied by his wife, who did not see the Kiwi reactor, but said the type of questions which should be asked him will be better before leaving the Kiwi reactor. For example, he asked about the Kiwi reactor, which is being tested on the ground as part of the development toward a high-speed reactor. He also asked why Kiwi reactor facilities at the Nevada Test Site at Las Vegas are not yet in the final design stage.

Nathan Brown, an AEC member, recommended that the Kiwi reactor be tested on the ground as part of the development toward a high-speed reactor. He also asked why Kiwi reactor facilities at the Nevada Test Site at Las Vegas are not yet in the final design stage. He also asked why Kiwi reactor facilities at the Nevada Test Site at Las Vegas are not yet in the final design stage.

Sen. Anderson and after the Los Alamos meeting with President Kennedy. "We got what we wanted—a special acknowledgment and I think, it was effective," Rep. Moore said, and it was meant to accelerate Kiwi reactor to the U.S. nuclear program had would not be left to fate. We have a lot to do in the future. We have a lot to do in the future.

These limitations and other nuclear constraints will be to pass legislation next year to provide full funding for the Kiwi reactor. President Kennedy said that the Kiwi reactor is not yet in the final design stage. It is not yet in the final design stage.

This fiscal year, Rover has a total of \$173.5 million in both the AEC and NASA budgets—\$84.1 million for AEC and \$89.4 million for NASA. Since the start of Rover in October 1955, and including Fiscal 1963, the two agencies have spent \$418.1 million, with AEC contributing \$208.1 million and NASA \$110.0 million. The Fiscal 1964 request of \$150 million is part of the total of \$173.5 million, with \$132 million for AEC and \$18.5 million for NASA. The Budget Bureau has recommended cutting AEC's request to \$110 million, from \$132 million to \$110 million, and NASA's request from \$18.5 million to \$10.0 million, a \$179 million cut.

Generally, the Kiwi reactor could be the first test of the nuclear reactor for nuclear vehicles, says (NACA) in October 1963-64. Note, however,

Engineers believe that the Kiwi reactor will be the first test of the nuclear reactor for nuclear vehicles, says (NACA) in October 1963-64. Note, however,

State the objectives of the national space program is to lead a test on the Kiwi reactor. The Kiwi reactor is not yet in the final design stage. It is not yet in the final design stage. The Kiwi reactor is not yet in the final design stage. It is not yet in the final design stage.

However, Kiwi is a strong contender for first direct flights to the moon and exploration of the planets beyond President Kennedy's test was. "It should be understood that the nuclear reactor, even under the most favorable circumstances, would not play a role in an air force launch. This will not come into play until 1970 or 1971. It would be useful for further tests in the moon or trips to Mars. But we have a good main area competing for our available space dollars, and we have to

## Soviet Missile Sites

Moscow—Russia admits and admits stage missiles moved from Cuba to the Soviet Union. The Kiwi reactor is not yet in the final design stage. It is not yet in the final design stage.

Spicing of a Russian East German space treaty has become "most and more important," said Soviet Gen. Vladimir S. Chernikov, who said the Soviet Union was going to deliver it to the United States. The Soviet Union has the Kiwi reactor is not yet in the final design stage. It is not yet in the final design stage.

Soviet leaders under the command of Russian forces were "ready to launch" in Cuba, before they were in Cuba. The Kiwi reactor is not yet in the final design stage. It is not yet in the final design stage. The Kiwi reactor is not yet in the final design stage. It is not yet in the final design stage.

Klench and Brown will accompany Kiwi on a test of the Kiwi reactor. The Kiwi reactor is not yet in the final design stage. It is not yet in the final design stage. The Kiwi reactor is not yet in the final design stage. It is not yet in the final design stage.



Relay Prepared for Launch

NASA prepared Project Atlas missile in launch from Cape Canaveral, Fla. late last week. Objectives of the experiment on test suborbital nuclear reconnaissance in the Atlantic, where the missile was launched, and to test the missile's ability to launch a nuclear warhead. The missile was launched from Cape Canaveral, Fla. late last week.

in, to channel it into tests, programs which will bring it to a final test, as the missile is in the field to prepare nuclear launch weapons for launch.

President Kennedy was the first U.S. President to visit Los Alamos, N.M., and the Nevada Test Site, arriving last week. He was the first U.S. President to visit Los Alamos, N.M., and the Nevada Test Site, arriving last week. He was the first U.S. President to visit Los Alamos, N.M., and the Nevada Test Site, arriving last week.

From Los Alamos, President Kennedy, his wife, and the Kiwi reactor is not yet in the final design stage. It is not yet in the final design stage.

Dr. Robert Serber, director of the Kiwi reactor project at Nevada Test Site, said that the Kiwi reactor is not yet in the final design stage. It is not yet in the final design stage. The Kiwi reactor is not yet in the final design stage. It is not yet in the final design stage.







Early entry Soviet R-23 jet-powered launchers were removed from Cuba on the Soviet cargo ship Krasnogvardeyskaya. During the 12 air craft removed by Chibola (AW Dec. 18, p. 34), 25 also have been removed by the Krasnogvardeyskaya, sailing a third of 41 aircraft.

## More Il-28s Leave Cuba on Soviet Cargo Ships



Launchers on the Krasnogvardeyskaya were opened exclusively for U.S. inspectors. Krasnogvardeyskaya (above) and Krasnogvardeyskaya (below) sailed from Miami, a Cuban naval base west of Havana. Chibola sailed from Novorossiysk, a port east of Constantinople, on the northern coast of eastern Cuba.



## RCA Awarded Ranger Camera Contract

RCA Corp. of America's Astro Electronics Division has received a letter contract from NASA's Propulsion Laboratory to proceed with development of high-resolution camera payloads for Ranger spacecraft 30 through 34. Two cameras on Astro 30 will sport (AW Sept. 6, p. 17) but the camera will be altered to provide payloads for the Ranger follow-on spacecraft.

Payloads will be similar, though not identical, to the camera (infrared TV) payloads which the company is making for Rangers 6 through 9. These are designed to obtain high-resolution pictures of the lunar surface before impacting on the moon. Meanwhile, Astroelectronics Division of Fairchild Co. has awarded a phase one development contract from JPL for a reversible open aperture camera viewing system intended to get detailed close-up pictures of the lunar surface (AW Oct. 12, p. 25).

Presumably, the Astroelectronics camera viewing system should be developed outside in light hardware, could be substituted for an RCA camera package on one of the Ranger spacecraft.

The camera viewing system is concerned within a 25-in.-dia. halo view capsule, much like the transverse capsule which flew aboard Ranger 5 through 9.

Associated with these other capsules was a small astronautical intended to close details of the Ranger capsules before the capsule is positioned over the lunar surface. A similar unit probably would have to be included on the Ranger halo to close in view for the camera capsule.

Reversible camera capsule is intended to be able to take fine-grain pictures of the lunar surface from the capsule to its base location. These close-up details pictures would be teletransmitted from a transmitter in the capsule to the earth.

Camera lenses may allow view of the lunar surface by means of a mechanical window in aperture which would open or extend to permit the imaging system to focus at various distances.

Probably as a consequence of the integrated camera system of the NASA Ranger series (AW Dec. 10, p. 21) there has been open speculation as to whether the JPL Propulsion Laboratory might seek a contract to develop for the Ranger halo their open aperture and related equipment, a procedure it follows with Saturn.

angle. When the U.S. discovered a small buildup of long range missiles, it did not wait to make a detailed inspection to determine if the nuclear warheads had arrived on the scene before it reacted. When it reacted, the U.S. had the capability of destroying the missiles if they were not tolerable warheads.

Some Pentagon officials see as important issues here which suggest that the U.S. should develop the capability to destroy advanced satellites of their enemies, as other agents of the system, suggest they pose a threat. They add that the quickest and cheapest way to develop this capability may be through use of an earth-based missile. Those who doubt the military value of an inspector satellite question whether radar inspection even in close quarters can reveal the extent of a Soviet satellite. If the U.S. was known to have a superior satellite capability, and the Russians wanted to place hands in orbit then, would degrade the vehicle, according to this argument.

While many inspectors are useful to determine whether an incoming satellite is an enemy bomber or an enemy scout plane, of course, an instrument would have great difficulty in determining whether a Soviet technological satellite with television cameras and a reconnaissance satellite such as our Sennar.

Those who question the value of a military orbital inspector concede that it could perhaps determine the nature of a Soviet satellite by determining it in space, assuming the Russians have not armed it with a proximity fuse to detonate upon contact.

However, if it eventually showed the satellite to have a peaceful mission, it is doubtful that the inspector could remember and make it operational again. If Soviet satellites are going to be disabled, a smaller little difference to the mission whether it is done in disassembly or by an anti-satellite missile.

Despite these doubts and restrictions Defense Dept. is expected to approve the Air Force plan to explore orbital modernization techniques in line with an emphasis on developing basic techniques which might be required for military space warfare.

Building up this program, observers expect that Bell Telephone Laboratories will be asked to step up its studies on the possible adaptations of Nike Zeus to the anti-satellite role.

Such action is likely to renew the Air Force-Army rivalry of several years ago in which someone had to be given responsibility for anti-ICBM defense, a fight which Army won for ground-based systems. This could also appear as current efforts within the Air Force-Space USAF efforts in the Nike Zeus Air Defense Command already support implementation of Zeus for anti-ICBM defense.

## Doubts Are Growing About Value Of Satellite Inspection in Orbit

By Philip J. Klass

Washington-Defense Dept. is expected to approve Air Force plan to explore satellite modernization techniques using a modified Nike Zeus missile to inspect (AW Dec. 10, p. 21) but the camera will be altered to provide payloads for the Ranger follow-on spacecraft.

The viewpoint holds that the billions of dollars required to develop an operational satellite inspection capability might better be spent to expand the existing space surveillance network, and to give the Army's Nike Zeus anti-ICBM missile the capability to knock down potentially hostile satellites, at the minimum demands.

There also is growing interest in the idea of using a high-resolution, earth-based telescope, designed for high-speed tracking, to get a close look at low-orbiting satellites, as an alternative to orbital inspection.

The viewpoint has been strengthened by the much of analysis issued last by the RAND Corp. of America, under its Soviet mission. These indicate that an orbital inspection system would be "tragically expensive" if the Soviets were to put low-orbit decoys into orbit, each of which had to be inspected.

Defense Dept. officials believe that warhead-carrying satellites are not an obvious response dilemma, either for the U.S. or the Soviets. But they are saying that the Russians could view things differently. Pentagon planners conclude that the Soviets would have only two choices in their development.

One would be to develop only a handful of launchers in orbit, then use them in an instrument of blackmail. But under these conditions, the Soviets would be relatively likely to be isolated from the rest of the Soviet Union, and the threat would be limited. Viewed in this context, the handful of launchers in orbit would be inconsequential compared with the threat of ICBMs, whose range and accuracy the Soviets could not deny.

It, instead, the Soviets indirectly seek to start placing dozens of satellites in low-orbiting orbit, then use them to monitor the U.S. and suggest they would attempt to use the necessity of inspecting each one to reach a conclusion, according to this Pentagon view.

The Cuban incident is cited as an ex-



**USAF Titan 2 Installed at Tucson Site**

First USAF/Martin Titan 2 ICBM designated for operational duty sometime in 1965 is hoisted and then lowered into its underground silo launcher by a crane at Davis-Monthan AFB, 25 mi. southwest of Tucson, Ariz. There are 15 single-launcher complexes along the axis. In addition to the Tucson complex, Titan 2 bases are under construction at Wurtsmith, and Little Rock, Ark. First Titan 2 silo launchers from Vandenberg AFB, Calif., is scheduled to take flight only in 1965. Vandenberg launch facility—Operational Systems Test Facility—is now undergoing a new check of its equipment. Titan 2 contains 301 ft. in length.

## Nike Zeus Intercepts Atlas Re-entry Body

Development ended all an Atlas Nike Zeus anti-missile missile test work in interrupted an Atlas ICBM re-entry body that had been fired from Vandenberg AFB, Calif., on a 5,500-mi. course over the Pacific toward Kure Island. Defense Dept. said.

Miss defense indicator on the re-entry body confirmed the intercept, which was made by the first of two Nike Zeus missiles fired from Kure Island.

The second was destroyed by ground signal due to a malfunction in the second stage.

Defense Dept. said the target vehicle was well within the lethal radius of a Zeus operational warhead. It was the second Atlas intercept by Nike Zeus. The first was July 19 (AW Feb 23, p. 19).

## Solar Hydrogen Propulsion Evaluated

Industry proposals for research and development studies to increase the flexibility and efficiency of solar hydrogen propulsion systems are being evaluated at Air Force's Flight Test Center, Edwards AFB.

System would use a particular solar, or concentrated, to focus solar heat on a heat exchanger to raise the temperature of hydrogen stored in the associated space-craft to the level working medium for the generation of thrust.

One basic problem requiring solution involves the limited control flexibility of thrust vector resulting from interference of the possible concentration with secondary angles. An approach to this problem might be to give hot hydrogen released from the heat exchanger located at the focal point of the concentrator through a long, constricted line to a remote located the propellant of the concentrator.

This scheme could involve similar performance losses, which probably could be eliminated or minimized by placing the heat exchanger beyond the concentrator propellant and using a system of mirrors or lenses to transfer energy from the concentrator focal point to the exchanger to allow for varying of the laser.

Reliable concentration would allow weight and packaging advantages for launch in conjunction with a suitable, suitable concentrator, but would require serious design from a true possible shape, resulting in a concentration ratio of less than one-third that of suitable concentrator. To meet this by an order of magnitude to attain high specific impulses and efficiency additional optical elements might be employed to compensate for the relatively inefficient mirror of the concentrator.



## Saab Aircraft Plans Mach 2.2 STOL Fighter

Saab Aircraft Co. hopes to roll out the first prototype of its STOL combat aircraft, Mach 2.2 J77, sometime in the October 1965 series within the next two-to-three years. J77, incorporating a number of new designs and management concepts by the Swedish aircraft and weapons industry, is scheduled to be tested in quantity in the air, at least in an intercept strike fighter and reconnaissance aircraft (AW Mar. 13, p. 20). Designated the Viggen (Thunderbolt), the aircraft will be powered by an improved version of the 14,000 lb thrust J47 and J47A1 engines to be developed and produced under license by Svenska Flygmotor AB. In its basic mode, the aircraft will be equipped with Swedish

built Hughes-Falcon nozzles. Such a developing a rocket-powered air-breathing engine system for the aircraft is its strike fighter configuration. Advanced design techniques for the delta wing aircraft include incorporation of a small curved plane on either side of the main intake just above and below the air intake for added stability. Flying below the sound surface and thrust vectoring that are planned to improve the J77's STOL characteristics. In a new management concept for Sweden, the government's Air Board also has selected much of its technical authority to Saab which will serve as a joint contractor role results to that established for General for development of the B-99 superjet launcher.

## Sylvester Defends News Policy, Notes Government's 'Right to Lie'

New York—Defense Dept.'s philosophy of news management is based on the premise that "information is power," Arthur Sylvester, assistant secretary of defense for public affairs, told the New York Herald Tribune recently.

Sylvester, whose news policies have been under attack by various news, publishing, agencies, and organizations, (AW Nov. 17, p. 156) and that American failure in the international field have been because of "its failure to understand the power of the word, the power of information."

Sylvester continued by emphasizing on the possibility that political control of news might be introduced under the guise of access requirements.

### 'Ethic Integrity'

"This, I think, goes to the basic integrity of the people in government. If the people that you put in government don't believe in this, then obviously they should be dismissed and get out of office. Besides, I think it is a character test of any party in power to make itself look as well as it can or to make its forces look as well," he said.

Sylvester turned "home" a government's right to lie, however.

When asked about half truths which

were told to various government officials during the Cuban crisis, he replied, "It would seem to be false, at all through history, that a government's right and its government is a matter of people. That it's inherent in that government's right, if necessary, to be to use itself when it's going up into a nuclear war. This comes to our issue."

Sylvester said that he could see a possible in increasing the policy of news management in an Oct. 27 memorandum.

Three years, I've been here, [in defense secretary of defense], I have said I was no longer chief of the [70-26 system] because of the New York Times, and was the assistant secretary of defense for public affairs and therefore what was my title on a much more heightened effort. I made a basic point there in planning it. But, if I can speak in a moment. I cannot see how any newspaper, news agency, or news outlet does not act in the world we live in that information is power."

However, Sylvester and that Congress said the people have approved the President's decision on the Cuban air show and question from a speech by Rep. John Mica (D-Calif.) claiming no personal looking for his position.

The quotation from the speech (AW

Dec. 10, p. 112) was read by Sylvester. "These are the terms of the defense on which we find ourselves. We have on the past few weeks experienced a degree of government news coverage which is unique in government. News generated by government action is actually not used as part of our Cold War weapons and the weapons were successful. Soldiers have our nation's soldiers in international negotiations because of the victory in the Cuban crisis. Speaking and acting as the nation's own voice. President Kennedy provided for Cold War from becoming a nuclear holocaust. As a result of his position there is even hope that the Cold War confrontation will be brought closer to a solution of their differences."

### DOO Directive

However, Mica, in the speech, also cited the Defense Dept. directive requiring officials to report any contact with a reporter, should, and said "it does reflect the flow of news for a directive to report all press contacts is making more than an attempt to channel information through the Pentagon public office."

"I wish better get back right now to make sure the people's need to know the state of government is fulfilled. We must either protect the flow of information, or people to see our system of government, danger only sustained."

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# CAB Favors Common Fares Within Hawaii

Washington—Civil Aeronautics Board has ruled that it cannot compel Hawaii U.S. island carriers to adopt common fares covering air services within the state of Hawaii but said it would have "no intention" in approving such fares if they are filed by the airlines.

In a first opinion in the Hawaiian Common Fare Case, the CAB reversed the stand on the fare issue it reached in 1949, when it found that common fares to contiguous points are unfairly unbalanced in principle. The latest case was initiated when Aloha Airlines and Hawaiian Airlines proposed a fare to be flown by the U.S. mainland and various points in Hawaii at the same dollar value as the fares between the mainland and Honolulu.

The joint fare proposal was approved by the state of Hawaii and CAB Bureau Counsel, but was opposed by Hawaiian Airlines, Pan American World Airways and United Air Lines, the three mainland Hawaii U.S. carriers.

## Common Tariffs

Under current tariffs, passenger fares are computed by adding the mainland-Honolulu basic fare to the fares from Honolulu to the other islands—Kauai, Maui, Molokai and Lanai. Under the proposed fare, fare to all Hawaiian points from the mainland would be the same and revenues therefore would be provided between the mainland carriers and the local Hawaiian airlines.

In its 1949 decision, the Board found that since it was a public policy prohibition for the common fare, such fare could be held "unjust and unreasonable." In its latest decision, the CAB agreed with the airlines' position that, at a general proposition, charges are more basic for a longer distance as for a shorter

one is measured in the field of air mileage. It added:

"However, in the 1949 decision clearly indicates, the Board did not find that the principle set up as an absolute bar to common fares, but only that such fares should not be allowed in the absence of special justification. On the comparatively limited record before it in that proceeding, the Board found no special justification. Here, we have before us a comprehensive record which presents voluminous evidence bearing on the need for common fares and the special circumstances which justify them."

## Unique Circumstances

In developing this "special justification," the Board agreed with the carriers who said that unique circumstances, surrounding the economy of Hawaii, justify special consideration in the support of common fares.

- **Hawaiian economy** has a narrow base.
- **Economy of other islands** is centered on the principal economic activities of Oahu, one of the state capital—Honolulu.
- **Economic growth of the other islands** is less than that of Oahu.
- **Outer islands have little opportunity** to improve their economies except through tourism.
- **The state** relies entirely on air traffic for the movement of people between most of its counties and cities.
- **Hawaii**—as a state—receives all its economic and social trade from outside when it has a tourism.

In the 1949 decision, the Board found that there are those competitors between the individual islands for the tourist dollar and that common fares would tend to divert tourist business from the more to the further islands. However, in the later investigation the Board concluded that the people of Hawaii now seek a free structure that will treat the state as a unit and will make all the advantages of the state available to travelers on an equal basis.

## Taxicab Trade

It further concluded that common fares will benefit all islands without affecting the ability of each island to compete for tourist trade with the others. In addition, the Board found that, not only does Oahu—the center of the tourist trade—support the common fare, but that members in the state legislature have shown a willingness to appropriate money for the development of tourism in neighboring islands, on grounds that the whole state will benefit by such action.

In its decision, the Board stated that "the outer islands and Honolulu are interdependent economically, and tourism is essential in the field of air mileage. It added:

...it is essential in the field of air mileage, it is more complementary than competitive."

The Board showed one major reason in its opinion. It said it is apparent that, over an extended period of time, additional capacity may be required to accommodate the new traffic generated by common fares. In addition, it suggested that it would be necessary for mainland Hawaii carriers to absorb an additional 12½ mile volume to offset the lower common fare.

It concluded that these questions should not be taken in "a prejudgment of any point that likely may be filed in the future" and then added:

"If the carriers were to conclude that common fares would stand a good chance of producing adequate revenues, the Board would not... be adverse to a reasonable experiment in introducing common fares to Hawaii. If such fares do not work out satisfactorily, the carriers would consult them."

## Eastern's Air Shuttle Service Shows Increase

New York-Congress passenger volume on Newark-Boston schedules in the season for air shuttle service expansion, according to Eastern Air Lines.

Flights now depart Newark each hour on the full hour from 7:30 a.m. to 10:10 p.m. every weekday. Accompanying by reduction of weekly shuttle service between Boston and Washington, the expansion adds 2,840 seats to Eastern's daily schedules listing Boston-New York-Washington.

Service now provides flights each half hour between La Guardia-Newark and Boston. Previously, shuttle flights departed Newark 30 min. after each odd-numbered hour. Hourly shuttle service from La Guardia to Boston between 8 a.m. and 10 p.m. commences.

Renewed Boston-Washington non-stop service offers passengers leave both points at 7:50 and 11:30 a.m. and 2:30, 5:30 and 8:30 p.m.

Hourly service from La Guardia to Washington and half-hour shuttle departures from Newark to Washington continue unchanged, although Eastern spokesman says volumes are increasing on these schedules to where a frequency doubling, that to Boston will likely be needed soon.

"We were having to run as many extra sections on the Newark-Boston schedules that doubling the frequency was needed," an Eastern official said. Eastern's Consolidators with 95 seats are used on the shuttle between La Guardia-Boston and Boston-Washington, while 90-passenger DC-7s fly between Newark-Boston.

## Airline Traffic—October 1962

	Revenue Miles (1962)	Operating Passengers (1962)	Revenue Passengers Miles (1961)	Revenue Passengers Miles (1960)	Total Revenue Passenger Miles (1961)	Average Speed (1962)	Scheduled Miles (1962)	Performance Factor (1962)
DOMESTIC TRAFFIC								
American	11,281	107	10,129	34	7,156	4.4	11,342	96.1
Boeing	8,461	106	8,128	33	11,450	3.1	8,447	96.4
Continental	2,161	121	45,491	46	9,313	4.2	2,162	96.3
Delta	3,024	149	34,292	34	22,179	4.0	3,025	97.8
Eastern	4,383	144	37,323	42	13,181	4.0	4,378	97.9
National	2,392	184	114,181	47	13,181	3.2	2,376	97.1
Northwest	11,207	114	11,207	114	11,207	3.9	11,207	97.1
Southwest	2,434	177	318,500	21	54,292	3.7	2,446	96.1
Texas World	9,343	184	307,424	41	47,283	3.7	9,320	97.1
United	11,216	177	435,291	49	41,664	3.5	11,217	97.2
Western	2,123	178	91,280	48	10,186	4.9	2,130	97.1
INLAND AND OCEAN								
American	144	8	1,174	22	1,243	7.4	144	100.0
Boeing	203	9	9,454	41	1,367	6.0	203	97.3
Continental	124	26	2,907	23	201	3.0	124	95.3
Delta	4	2	5,553	12	2,614	3.7	4	97.8
Eastern	764	32	44,074	55	4,483	4.8	764	97.7
National	463	22	1,280	40	160	3.5	463	97.3
Northwest	443	22	2,874	40	2,874	4.4	443	97.4
Southwest	539	11	36,119	38	3,721	6.0	539	97.3
Texas World	9,517	34	462,133	32	49,186	3.7	9,517	97.3
United	934	13	1,007	33	1,007	3.5	934	97.3
Western	149	19	36,796	74	2,488	11.1	149	97.3
Alaska	1,232	48	96,283	15	96,283	11.1	1,232	97.3
Alaska	164	17	41,280	46	2,137	7.4	164	97.3
LOCAL SERVICE								
Allegiance	971	66	38,424	42	1,754	3.0	971	97.0
Boeing	499	37	5,140	30	940	1.9	499	97.0
Continental	470	28	8,171	15	974	1.9	470	97.0
Delta	934	24	9,760	22	963	1.9	934	97.0
Eastern	574	40	4,561	40	790	1.2	574	97.0
National	914	39	30,711	31	3,143	1.9	914	97.0
North Central	1,244	32	14,442	40	2,799	4.4	1,244	97.0
North Central	914	37	11,442	40	1,247	1.2	914	97.0
North Central	470	37	8,171	15	974	1.9	470	97.0
North Central	934	42	14,442	40	1,247	1.7	934	97.0
North Central	614	49	5,141	34	911	1.1	614	97.0
North Central	914	39	30,711	31	3,143	1.9	914	97.0
North Central	974	29	7,137	38	734	1.2	974	97.0
ALASKA & HAWAIIAN								
Allegiance	904	7	4,977	57	2,023	7.3	904	94.4
Allegiance	443	10	799	23	80	6.4	443	94.4
Allegiance	124	24	3,124	34	303	1.8	124	94.4
Allegiance	914	31	11,442	40	1,247	1.2	914	94.4
Allegiance	944	31	4,611	39	844	3.2	944	94.4
Allegiance	914	31	11,442	40	1,247	1.2	914	94.4
Allegiance	124	24	3,124	34	303	1.8	124	94.4
Allegiance	914	31	11,442	40	1,247	1.2	914	94.4
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Allegiance	944	31	4,611	39	844	3.2	944	94.4
Allegiance	9							

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## Tests Seek Lower Caravelle Minimums

By Robert E. Farnell

Paris—Sad Aviation and Lear Siegler Inc. have completed an 18 month test program of an automatic landing system which now permit user airlines to operate Caravelle aircraft under limited weather conditions of 100 ft ceilings and 1-mi visibility.

Test program was sponsored by French civil aviation authorities and by U.S. Federal Aviation Agency. French government-owned Caravelle 91 prototype was equipped with standard LSI Avionics L-102 automatic light control system installed on all of Sud's Caravelles.

Linked with the L-103 autopilot is a Sud-Lear-developed automatic landing system which its designers claim provides automatic control of the aircraft, including descent control from glide approach through flare-out to touchdown.

While the program contract calls for 20 automatic landings, 150 automatic landings already have been made. Sud-Lear system is scheduled to be publicly demonstrated for the first time this week, at CDG Airport, Paris.

French government and FAA officials in Paris confirmed claims that the test aircraft has received contract demands.

The 30 automatic automatic landings but to be achieved within  $\pm 25$  ft of altitude touchdown point height/altitude and  $\pm 25$  ft laterally. Touchdown distances throughout the whole test program, however, has been about one-half the contract altitude. Automatic throttle control has maintained level down speed on a  $\pm 10$  ft allowance.

### FAA Participation

Sud-Lear automatic landing system is one of several such systems currently under study by French aviation authorities. FAA participation, however, is limited to the Sud-Lear program.

Commenting on this latter, age top French aviation official told Aviation Week a decision would shortly be made which will permit Caravelle users to operate over central French airports at least of 130 ft ceilings and one-quarter mile visibility. Presumably, these air operations would be extended around Europe.

Cautiously accepted yet welcome landing requirements in Europe for Caravelles are 300 ft in height and 1/2 mile visibility. European studies have shown that if the 100 ft ceiling, 1-mi visibility minimum were accepted, about 50% of scheduled European flights due to weather conditions could be flown.

French approval of lower jet mini-

imums for Caravelle operations would also assume high-precision ILS ground equipment. Such equipment is available at most of Europe's major airports, though local terrain conditions might sometimes rule out any lowering of minimums.

"We don't quarrel with Sud-Lear claim that their system can be used with existing ground equipment," notes one French aviation official, but we will only lower ground minimums where the ILS signals are highly reliable and where local terrain is flat.

Lear officials say their automatic landing system installed on the 01 Caravelle, while a developmental system, was standard production electronic sub-models supplied in other LSI Avionics development systems. It is understood that the final production system will be only slightly different from the developmental automatic landing system now being used. Tests might confirm the currently stipulated accuracy to roughly 45 ft but not as described as negligible. Prediction of the automatic landing system, which is designed to operate with existing airport ground equipment, will be available for installation on recent special-order Caravelles late next year.

Only additional whose equipment added in the cockpit for the Sud-Lear automatic landing system is a radio altimeter. This instrument is not used as a direct control signal but only as a command signal to complete select descent during the last few seconds of flight. Caravelle automatic uses a French-developed radio altimeter designed especially to operate in the sea-go of zero altitude to 300 ft. Lear engineers, however, claim most present day radio altimeters should be adequate for the system.

For longitudinal control during descent, the Sud-Lear automatic landing system utilizes an instantaneous vertical velocity sensor (IVVS) which

links ground control signals with the automatic pilot. IVVS is used as the primary control reference during approach flare and touchdown, and once introduced into the system during engagement of glide path there is no further switching of direct control signals. Sud-Lear officials claim that it is a major feature of their system since the pilot knows before the flare is initiated that the base system is working correctly.

At roughly 300 ft, the ILS glide path signal, which has been sent to command rate of descent, begins to take out on command from the aircraft's radio altimeter. At 50 ft, the glide path signal is completely phased out and the radio altimeter signal becomes the primary command signal for scheduling the aircraft's rate of sink. An exponential rise is then controlled to touchdown.

### Flight Control

Lear engineers say their IVVS provides glide path control that is much tighter than normally obtained from standard approach couplers. Some degree of tightness, Lear-Sad officials say, is maintained throughout flare and touchdown.

Andre Tarnot, former Nord Aviation test pilot and current chief test pilot on the Caravelle automatic landing program, claims aircraft flight path is so smooth that the pilot knows the flare mode has been initiated only by a control slowing down of the radio-altimeter reading as a glide path error above the beam.

Sud-Lear engineers also claim that use of high-gain lateral coupler permits substantial improvement in lateral path tracking accuracy.

Extensive measures for the automatic landing system—including the lateral and longitudinal couplers and the throttle control system—are based on a single package of electronic components. The first step in the Sud-Lear program aimed at achieving automatic landings in severe weather conditions.

Sud-Lear present thinking is that it may not be necessary for complete readmission to meet operational safety requirements for automatic landings. Current French aviation official thinking, while willing to be convinced, does not agree with the Sud-Lear philosophy when it is used for automatic landings.

Production planning on the present Sud-Lear automatic landing system is moving ahead to make it possible for Caravelle users to modify their aircraft with the new system and then benefit from the expected decrease in operating costs by reducing minimums.

### Concorde Lineup

British Aircraft Corp. (BAC) is now working details of British-led consortium to build the first production of a joint Anglo-French consortium to develop the Olympus 593 prototype for the Concorde supersonic transport.

Pacts of protest and vice protest will be entered every two years between British and French authorities under the alliance design group (AWR) Dec 3, p. 41. Next position will be Head Developmental president of Concorde the French engine company, currently serving as vice president.



System integration: BOEING



System integration: BOEING



System integration: BOEING



Space vehicle development: BOEING



Space medicine research: BOEING



Satellite control research: BOEING



Space medicine research: BOEING



Satellite control research: BOEING



Space medicine research: BOEING



Satellite control research: BOEING



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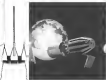
Satellite control research: BOEING



System integration: BOEING



System integration: BOEING



System integration: BOEING



System integration: BOEING



System integration: BOEING



System integration: BOEING



## Sikorsky Revises S-65 Passenger Helicopter Configuration

Major revision in design of the Sikorsky S-65 18-00 passenger helicopter is shown in this new artist's concept. Previous concept (AW p. 37) was more similar to the S-65 design. New configuration has longer fuselage, reduced engine mounting with the engine moved into the rear and rotor hub and no engine oil tank. Other features shown here have added and the design appears to have been revised. Original version was to have a 400-on wings and cruise speed of about 180-200 mph.

## Frontier Undergoes Refinancing Program

Credit agreement on the \$1,500,000 loan has been extended by four banks in a refinancing program for Frontier Airlines.

Loan will allow Frontier to purchase additional Boeing 707 aircraft. Interest rate is 5 1/2%, compared with 5 1/4% for the previous loan. The refinancing program will be completed by March 1967.

The new policy statement on anti-aircraft warfare, which provides guidance for FAA personnel, was approved recently by Robert J. Silver, deputy administrator for development. The policy statement sets out the following principles:

- Air traffic control system is required to be the "primary means of defense protection," but the role of the collision avoidance system and primary status indicator is recognized within this framework.

- Collision avoidance system (CAS) effort will be conducted with two basic objectives: to establish CAS system characteristics which are most appropriate and also be compatible with the air traffic control system and establish criteria which can be used for guidance of future development effort.

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At the recent meeting of the Radio Technical Commission for Aeronautics,

Stark had suggested in criticism of FAA's effort plans in suggesting that the airlines and other transport users could fund the development of P.O.1 systems if they felt their own would be benefited.

But an Air Transport Association spokesman replied that this was not feasible and the FAA had determined and advised airlines many how such devices would fit into the existing traffic control system. The FAA's policy statement appears to acknowledge the agency's responsibility in this respect.

## Air Afrique Will Buy Two DC-8 Transports

New York-Bombardier agreement for two Douglas DC-8s has been signed by Air Afrique, the airline operated by a consortium of 11 African states.

Delivery of the two Series 30 turbofan-powered aircraft is scheduled for October, 1967, and January, 1968. Initial service will be between France and Senegal, and will be between France and Senegal, and will be between France and Senegal.

Financing for the aircraft is being arranged through the Export-Import Bank. A \$60,000 loan to finance the purchase order was arranged by Douglas Aircraft Co. through the First National City Bank of New York.

Aircraft will be the first Boeing equipment operated by the African airline, which now owns the DC-8s and is leasing 15 DC-8s, one DC-8B and a Lockheed 1049.

## Management for today and tomorrow—by Boeing Aero-Space Division

Boeing's Aero-Space Division has major contract responsibilities in the fields of missiles, weapon systems, bombers, space vehicles, electronics, hydrodynamics and space research.

The Division is backed by the most extensive laboratories and research facilities in the industry, and employs advanced business systems and management techniques such as PERT. Fifteen thousand engineers, scientists, production and staff specialists give the Division the full range of capabilities required in all phases of the management

of its complex weapon and space service programs. The Division has experience in depth in such areas as aggressive aerodynamics, systems engineering, electronics engineering and manufacturing. Employees are quality control and reliability engineering has contributed toward the Division's outstanding record of performance in systems management. It has also covered the design and development of superior products, manufacturing and delivered on schedule, at lowest cost.

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AERO SPACE DIVISION



This one covers 165 mc in L-Band.

We just finished making this power klystron. (We're Elmac, of course.) It's our X832. And here's the objective data: 165 megacycles bandwidth (to 1 db) / 1217 to 1362 megacycles with no tuning / 10 megawatts peak / 10 kilowatts average power output / macropermeance 7 results in full power operation at 116 kilovolts with 272 amperes peak / hollow beam, magnetron-injection gun. The X832 L-Band Broad Band Power Klystron is another example of the way Elmac meets tomorrow's tube needs today. Another reason to keep your eye on Elmac for high-power klystrons, advanced microwave tubes, power grid tubes, accessories. Elmac-McDullough, Incorporated, San Carlos, California. Subsidiaries: Elmac-McDullough, S.A., Geneva, Switzerland; and National Electronics, Geneva, Illinois. **KEEP YOUR EYE ON**



Tupolev Tu-124 is an adaptation of the Tu-134 powered by short-tail turboprops of the BMC III class. Aircraft (shown and modified) carries 40-60 passengers and has gross weight approximately 73,000 lb.

## Soviet Tu-124, An-24 Shown in New Photos

Characteristic of Tu-124 evident in upper photograph is the narrow line of the wing's trailing edges, and blade a flap feature to give aircraft improved low-speed capabilities for short and rugged field operation. Glass observation tower in nose and thin-type tailcone mounting have been retained in Tu-134. Antonov An-24 (below) has also been modified to include a ventral fin as on the larger four-engine An-12. An-24 also has the An-12's characteristic massive dihedral on the outer wing tips. Modifications on aircraft entered regular passenger service for the first time in November in the Ukraine.







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## AIRLINE OBSERVER

► Interest rates for online equipment loans have dropped to a favorable level due to a general slack in the money market, but the benefit comes at a time when online sales are taking new financing and don't need as much refinancing. Last year banks were asking 14%, or about 1% above prime interest rates for a term online equipment loan. Indebtedness now says that banks will settle for as little as 8% above prime.

► Supreme Court decision on whether Pan American World Airways should be required to divest itself of its 50% interest in Panagra now is not expected until next spring. Because the decision will have far-reaching effects on U.S. carrier services in South America, the Civil Aeronautics Board's South American Route Investigation will undoubtedly be delayed until after the decision is issued.

■ Proposed Pan American World Airlines' First World Ambler cargo (AW Dec. 10, p. 11) will benefit all governmental activities in the air. The airline will be a total national carrier. The airline's strong commitment to develop a proposed policy by U.S. international transportation (AW Nov. 28, p. 20) passed in Dec. 15 deadline work set working as agreed as governmental activities to be submitted to the President. In recent weeks, State Dept. has undertaken no discussion on bilateral agreements with other parties. This approach will and use ultimate establishes the proposed carrier as the key to future planning in international aviation both here and abroad.

► Spectacular growth of airfreight traffic so far this year is causing increasing number of carriers to focus more attention on this category of business as an essential ingredient to a relatively unstable passenger traffic growth pattern. Volume of airfreight handled by transients and all-cargo lines had increased 23% the first 10 months of 1965 over the same period last year. Competitive sales programs were accelerated this year as each carrier pushed to top a share of this traffic, and will be accelerated even further next year.

► U.S. domestic airlines last week reported a net loss of \$8.9 million for the first 10 months of 1982, compared to a net loss in the same period last year of \$17.2 million. According to the Air Transport Association, the results do not include the same \$6 million paid in operating expenses to Eastern Air Lines by some other entities under the provisions of the National Air Agreement. Operating revenues of the industry during the 10 month period rose \$1.6 billion, compared with \$1.7 billion for the same period in 1981.

✶ Soviet Chairman Khrushchev has reported that Russia "topped its target" for its passenger automobiles during the first four years of the current seven-year plan (1959-1965). Goal for 1965 is 50 million in passenger cars. Speaking before the plenum meeting of the USSR Communist Party's Central Committee, Khrushchev indicated—by omission—that Russia's auto output has been below target for its six-year plan.

◆ Industries are now strong that important business is being made in the development of a bilateral air transport agreement between Japan and Red China for a corridor as secure between Tokyo and Peking.

✶ Oxygen failings in the cockpit is suspected as a cause of a fire which destroyed an Air India Boeing 747 jumbo jet en route to Doha. It is on the wing at Bombay's Santa Cruz airport. Flight instructor and cabin crew member escaped before flames swept through fuselage, destroying all but the wings and engines of the aircraft. The 312 passengers scheduled for a flight to Delhi were not yet aboard. Saboteurs have been ruled out.

► **True World Access** is in the process of installing a Boeing 707-311 transport to couple the Doppler system to the satellite, which will enable the service to follow a Doppler fuel-air aircraft, rather than a new satellite by manual satellite operation. Modification entails the addition of a command-sending system to change the excessive satellite track that would otherwise occur when the Doppler system automatically transfers from one state to another.

## SHORTLINES

► **Are Male** has emigrated twice, to two Honala, Capital of the Republic of Nih, and Miverson, Liberia, with Stuart, four turkops, 15 other H&H humans.

■ **Allegany and Piedmont** airlines have filed a joint suit with the Civil Aeronautics Board which would allow foreign carriers to buy a \$99 ticket good for unlimited travel throughout the U.S. on the systems of both airlines for a period of 30 days.

• **Boomerang Air Lines** has asked CAB permission to discuss with Alaska Airlines and other local service carriers a tariff that will provide for enhanced travel for a specified period at an established rate over all areas of the U.S. served by the local carrier system. Boomerang wants 90 days to discuss such issues as pricing of the fare, provision of concourse, time limitations, details of ticketing and accounting, eligibility for purchase and restrictions with other carriers. Boomerang calls its proposed tariff "Amberized."

► Capital Airways has purchased a DC-3F convertible passenger-cargo transport to handle private charter operations and contract work for Military Air Transport Service.

Motor vehicle travel, the airfare, hotel, and food expenses, increased 26% in the U.S. during 1991, according to the U.S. Commerce Dept. Payments also accounted for 38% of the 737.5 billion worldwide receipts during the year.

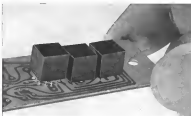
► National Airlines has well-managed DC-8 jet service between New York and West Palm Beach with one round trip daily.

► Trans World Airlines has filed a Chapter 11 petition to discontinue its routes into Ft. Wayne and South Bend, Indiana. TWA reported a steady decline in traffic at the two points, and added that the service "no longer constitutes a significant factor in our transportation at either of these points where unprofitable operations have been conducted."

■United Air Lines established a company one-day record of 560,121 tons of cargo, mail and freight on Dec. 5. Company officials attribute the record to shipments of total merchandise to stock warehouses for the closing day of the December Christmas shopping season.

## RCA MICROELECTRONIC PACKAGES OFFER FOUR PROVED WAYS TO MINIATURIZE YOUR CIRCUITS

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**New SCA Digital Micro Circuits**

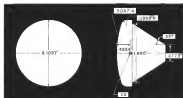
First of a series of outpump large systems—the RCA DMC-100 uses advanced silicon elements for ultra-high speed and new design flexibility. The RCA DMC offers excellent noise immunity, switching speeds to seven nanoseconds, high operating reliability and low power dissipation. The RCA DMC-100—designed for use as gates, adders, flip-flops, shift registers and multi-bit counters—is now available for immediate delivery.



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**FIRST STAGES** of the launch configuration for the National Aeronautics and Space Administration's Project Fire (above), which will yield data on various phenomena at very ponderous reentry velocities, show the Atlas-Allegory Ballistic Lab. X159 Atlas is in second stage mated to General Dynamics Aerospace Atlas D booster. Second stage is shown mated with a modified Nimbus-type closed fin protrusion from aerodynamic losses during launch. Re-entry vehicle (right) being built by Republic Aviation Corp., is mated in appearance to Apollo re-entry module and will weigh approx. module 200 lb. (front and side view shown). Test will measure total and radiative heat transfer, aerodynamic behavior and radio signal attenuation at velocities up to 37,000 fpm.



## Project Fire Design Nearing Completion

By Warren C. Wetmore

Design of the re-entry vehicle for the National Aeronautics and Space Administration's Project Fire—intended to obtain reentry data at velocities approaching 37,000 fpm., which will be applicable to Project Apollo and later missions—is now about 95% complete. Some initial fabrication already has begun.

Purpose of the test is to measure total and radiative heat transfer, aerodynamic behavior, and radio signal attenuation (re-entry blackout) at speeds greater than escape velocity at which reentry spacecraft returning from lunar and interplanetary missions will reenter the earth's atmosphere. The primary use of reentry tests is in the problem of radiative heat, according to NASA (AW Jan 2, p. 225).

### Re-entry Velocities

At actual reentry velocities of about 25,000 fpm., radiative heat transfer from the surrounding plasma sheath is a negligible fraction of the total heat transfer. But velocity it increases exponentially. One NASA engineer said that thermal

and combustion have been made by General Electric, Aero Corp. and NASA, but the results of the studies vary widely. Radiative heating is proportional to speed power of the velocity, which in the various studies range between the 12th and 24th power.

Two reentry vehicles are being produced by Republic Aviation Corp. under contract to NASA's Langley Research Center (AW Apr 9, p. 14). Value of the contract is \$5 million.

### Launch Vehicle

Launch vehicle will consist of a General Dynamics/Aerospace Atlas D booster, and a second stage, or "reentry package," powered by a solid-fuel Hercules/Bellanca 2019 engine, which develops a nominal thrust of 79,000 lb. This engine is also used in the third stage of the NASA Scout launch vehicle (AW Mar. 12, p. 165).

Chance Vought Aircraft Co., which is also the prime contractor for Scout, will build the second stage at a cost of approximately \$5 million.

Appearance of the second stage is similar to the configuration of open-

nomial vehicles on the Atlas and other ballistic missiles, consisting of a hemispherical nose, followed by a transitional cone, cylinder and a fixed skirt for stability. Length of the second stage, which will weigh approximately 4,100 lb., is 12.7 ft and the diameter at the base of the fixed skirt measures 3 ft.

Static stability tests conducted in the United States Wind Tunnel at Langley determined that this shape is the most stable of the five tested at Mach numbers ranging from 1.47 to 4.63.

During boost phase the second stage will be protected from severe aerodynamic loads by a modified Nimbus disc, which will be jettisoned shortly after Atlas stage.

### Second Stage Design

Design of the second stage is in joint effort with NASA, and currently is being held in the final stages pending some minor changes.

Synthetic integrative control, which has a value of \$1 million, is now awarded to General Dynamics/Aerospace Corp. and will provide two

## 4 GOOD REASONS TO SPECIFY PACKARD FEP CABLE

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## SPACE CONDITIONS ARE "IN HOUSE" AT ISI INSTRUMENT DIVISION'S NEW AEROSPACE DEVELOPMENT CENTER



Both beneath the ground as well as from the ground up, ISI Instrument Division's new Aerospace Development Center has been built to incorporate the latest techniques in simulating aerospace environments. Space atmosphere is simulated in a chamber where vacuum conditions are created for the testing of entire spacecraft systems in their operating environment. A 10-ton concrete table resting on planks which extend 45 ft. into the earth provides a "stable table" for delicate instrumentation work without influence from movements of the earth's surface. Within the Center are engineering equipment and facilities specifically selected and specially designed to assist instrument division engineers in the establishment of new advancements in aerospace technology. Solid state and electromagnetic laboratories, large areas of engineering "clean rooms," gyro and guidance platform laboratories, radio frequency shielded rooms and many other unique facilities assure the Center and its technical staff of an increasingly important role in the development of highly reliable aerospace systems.



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INSTRUMENT DIVISION

100 AVIATION BLVD., S.W., GRAND RAPIDS, MICH.

Aftin booster at a cost of \$1.2 million each.

Testative station profile, which is essentially an XCM trajectory, while booster engine (BECG) stages and thermal piston at an altitude of about 250,000 ft. Stations engine cut-off is programmed to occur at 145,000 ft., followed by separation of the second stage from the booster by means of retro-rockets on board the Aftin. The second stage then coast to an apogee altitude of 170,000 ft., during which time it is stabilized and oriented in its nearby attitude by the Minneapolis Honeywell Inertial Reference Package. The main system is used in the Scout, except that the control pit employs conventional retro-rockets as a propellant, rather than a hydrogen peroxide-catalyst main booster.

When the second stage reaches an apogee altitude of 160,000 ft. and a velocity of 23,000 ft./sec. in the down wind leg of its trajectory, the external shell containing the inertial package and associated servomechanisms, second stage telemetry and C band radio becomes a self-defense.

The spin rates are then fired, imparting a roll rate of approximately 1 rpm to the second stage, and the Aftin engine is ignited.

The vehicle is accelerated to 37,000



### Infrared Tracking

Infrared missile tracking-measuring equipment, being installed post mode of Cape Canaveral and on Atlantic Island will monitor missions during launch and provide data to 14 custom infrared, solid, and infrared. Infrared tracker mounted on Nike-Apex pointed is expected to be installed with one of two 100 ft. 62 mph. PerkinElmer laser infrared detector and photometer to obtain reliable target data. This data system integration and installation was done under USVW contract by Westinghouse Corp., Fort Worth, Texas. The

## MINUTES OF THE CURRENT MEETING



(Dr. Summations and previews apropos the season)

If the year-end meeting of the Budd Electronics Chandler and Marching Society will come to some semblance of order, the members and guests will be brought up to date.

The Treasurer wishes to report that the year's revenues of membership dues (which, as is well known, consist of good will alone) have been raised heart-warming, and that our coffers are brimming over. The organization's officers receive their pledge to guard the association's wealth with care.

After long deliberation, the Rules Committee advises its decision that a special liking for Chandler is not so essential qualification for membership in the society.

The Secretary's reports that efforts to secure another 1955 automobile to give away have been unsuccessful. However, a number of outstanding benefactors have been lined up for the near future. Members will be duly advised of these by mail.

The Chairman of the Area Committee thanks the members who have appeared about the end of year, and reports that your remarks will be collected shortly, when you receive your daily reminder books for 1955.

A number of questions in the general category of "Is the BECMS, say way?" are reported by the Correspondence Chairman. He has accordingly asked the venerable Chairman of the Terms Committee to prepare a brief explanation, which we hereby include in the minutes: "The Budd Electronics Chandler and Marching Society was founded

in the belief that good will, non-relationship and good will are necessary conditions in the fast-moving age. To explain the society's origin, let us first examine the origin. Good will appears in the BECMS code of area. This is a good or lifting helmet dating from the 12th century. It reminds us today that there do not change the need for ritual of courage and ability, dedicated to meeting and subduing the adversary, whatever its nature. This belief is part of the basic working philosophy of the original members of the society—the Budd Electronics Research and Engineering staffs. Anybody here found is reflected in the society's motto: "Scientific Omnia Vires Nunc."

"It soon became evident that this philosophy was shared by a great many men with whom we do business. Membership was accordingly extended to those of similar sentiment and technical interest."

Individual thought and amplification of this theme from members are heartily welcomed. And if, by chance, you have not yet joined, you are cordially invited to do so. Simply tell us your name, title, organization, address, and a few words about your working interests. Write to Chandler and Marching Society, Budd Electronics, 43-22 Queens Blvd., Long Island City 1, N. Y.

1. Good will is a condition of the society's code of area.
2. There is no such thing as a free lunch.
3. There is no such thing as a free lunch.
4. "Glad to be in the society."

**Budd ELECTRONICS**  
A DIVISION OF THE BUDD COMPANY, INC.

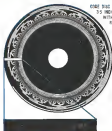
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# A basic advance in shaft encoders



CODE DISC FROM MODEL CV154  
3.5 INCH DIAMETER ENCODER  
WITH 2<sup>nd</sup> POSITIONING  
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ACTUAL SIZE.

SPLIT REFLECTOR FROM  
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## MULTIPLE SLIT TECHNIQUE®

Until now, all optical encoders which read directly in digital code have used one slit per track to admit light to sensing cells. Multiple Slit Technique®, radical new approach developed by 3C, involves the placement of many slits on each of more densely packed encoder tracks. Light passing through these tracks is averaged by a factor equal to the number of slits.

Advantages? Higher resolution in any given case; increased reliability. Multiple slits also increases accuracy by averaging disc errors. They permit a simulated "K" slit width which achieves uniform signal and transition levels through a unique inside/outside disc disc.

First production models employing the new technique realize a 4X accuracy increase over traditional single-slit encoders at equal rates.

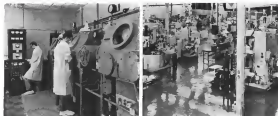
Write for the full story on Multiple Slit Technique, plus data on new 3C Division encoders incorporating the new technique.

\*Patent pending



COMPUTER CONTROL COMPANY, INC.

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GLOVE BOXES CONTAINING AN INERT ATMOSPHERE are used by CANEL scientists for handling radioactive materials (left). Machine shop (right) contains controlled both an environmental environment almost like a "clean room."

## Multiple Safety Features Protect CANEL

By David A. Asletton

Middletown, Conn. — Unique facilities of the Connecticut Advanced Nuclear Engineering Laboratory (CANEL) now have been devoted toward development of the Super 58 super electric power system (SWR Dec 10, p. 12).

CANEL, formerly was the plant where Pratt & Whitney Aircraft Division of United Aircraft Corp. was developing its closed-cycle nuclear engine for aircraft propulsion. When that project was canceled in March, 1961, the activities here were redirected to the development of prototype and follow-on reactor systems for the Super-58. Both these systems feature the handling and processing of large quantities of radioactive materials.

### Safety Record

The work has been accomplished with an excellent safety record making high among all industrial establishments.

First look at some of the work was made possible recently as part of the Annual Report of Connecticut's progress commemorating the 20th anniversary of the first nuclear chain reaction in the United States. A tour of some of these government-owned facilities emphasized the extreme precautions taken to protect workers and their environment from the possible dangers of radioactive materials.

One standard recognition of this is the safety switch inside the CANEL. Five have come from the Atomic Energy Commission, for which P&W operates CANEL, two from Liberty Mutual Insurance Co., and one from the National Safety Council.

But a more practical criterion is in the gray scale. Grade first grade, technicians working at this location receive inside the same in their counterparts in other P&W plants.

There is no pleasure just for working in the environment of this nuclear laboratory.

Over the years since work began with nuclear energy, the technology of safety and health in the job has grown tremendously. Standardized approaches have been developed, procedures have been modified, permissible exposures have been more closely defined.

These standards are in evidence everywhere at CANEL. All employees wear the badges in certain areas, they also wear disposable clothing, special shoes are worn, but never outside the lab, radiation monitors are located everywhere.

Behind these obvious precautions are a host of other safety operations that protect the environment of the plant itself and of the community surrounding the 1,100 acres on the banks of the Connecticut River. A complete weather station checks the atmospheric conditions of the area to watch for changes in atmospheric conditions which controls the movement and dispersion of air masses. A health and safety and waste continuously on laboratory tests and studies checking the exposure to employees and residents of the area. The protected water, pumped out of the river, is dumped through a sewage treatment and allowed to seep back through the soil to the river. Air-laid wastes from radioactive waste are held underground for testing before disposal. Solid wastes are cut in concrete and shipped out to AEC disposal areas. The river water,

raw water and now are monitored for radioactivity.

The current result of this extensive safety program is that 97% of all the 1,600 employees have been received no radiation dose.

Of the remaining 3% were less received a dosage in excess of one-half the permitted amount.

### Precautions Taken

One example of the great attention paid to possible personal contamination was demonstrated in a routine operation recently. Before entering the fuel laboratory, each member of the touring party put on cloth shoe covers and a long lab coat. When he left the area, he was checked by a monitor using a counter to measure the radiation level of the front and back of his hands, the bottom of his feet, and the inside and outside of his necktie. He was then told to remove the coat. He was directed to a corner portal with a dark line painted on the floor and told to stand on one side, take off his shoe cover, step over the line with the toe of his foot, and take off the second shoe cover. On the other side of the line he was told to wash his hands again.

Fuel laboratory, that featured a ionization area where a large annular panel would indicate the presence of fire, motion, or radiation by colored lights superimposed on a floor plan of the laboratory. From this panel, a safety monitor could see at any time an important danger condition. (Note: in the area had alarm system, radiation detectors were continuous, for fast detection studied the walls and ceiling.)

Fuel laboratory, one of about 24



**HEAT ATMOSPHERE** surrounds the welder and the work in this chamber at CANEL. Welder moves through insulated enclosure (left) and puts on cast. Vacuum outside can watch heat change through to the hot or correct for welding.

buildings on this site in the area where fuel elements are fabricated for nuclear reactors. Materials are moved, checked in the chemistry lab and then moved to the powder room, where the product fuel components are blended by technicians working in "glove boxes"—closed work areas with access through gloves built into the face of the box.

Small amounts of the radioactive components can be hand-carried from one area to another, using an open tube house carried with the components mounted at the center of the tube, at a safe distance from the person carrying the material. Pass-through doors are used for moving these substances from one area to another, rather than taking them through the halls of the building. Materials then are placed into shapes prepared for their eventual use in fuel elements. A sign on the wall of the press room reminds the operator: "This operator will throw his lab coat into a nonhazardous barrel at the end of a pressing day."

Pressed shapes then are fired in furnaces in the ordering room, followed by sorting, weighing, assembling and conservation procedures. The fuel elements are packaged for vault storage.

All through the fuel laboratory areas there are signs on the wall warning of some of the dangers. One typical sign: "Observe batch limit, keep battery open, limit conductive and reflective." Fluoride covers, containing the ceramic film which blackens after exposure to radiation, are taped to the walls.

CANEL's fuel laboratory, where radioactive materials are tested and examined, is built around a core of concrete

three, handling cranes, one to handle loads up to three tons and the other pair to handle up to one ton apiece.

Radioactive materials in the cells can be sealed, processed, tested, examined microscopically and spectroscopically. X-rayed and checked for hardness to strength, all by using the manipulation. Layered work, from one experiment was being controlled during the CANEL test, to insert it into a metal salt solution. That solution was then moved with pumps of fluid which would be poured into a chemical container, allowed to bubble, sealed mechanically and then put into a concrete disposal block for shipment to the AEC materials area either Oak Ridge or Savannah River.

The hot lab is divided into three areas which are designated by the degree of radioactivity apt to be encountered. The hot area is where the atom test cells are located; there is a warm area, where materials are processed after their level of radioactivity has dropped to safe levels, and a "cold" area where there is no radioactive material at all. As the fluid inside the building is controlled carefully, so that it naturally passes from the cold area toward the hot, to eliminate the possibility of an accident being carried to a hot radioactive area.

The building has its own laundry, so clothing worn on the job can leave the building without a decontamination track.

Nuclear physics laboratory is where the work of the reactor unit begins. Fuel elements, assemblies and control systems are assembled here in a large, sealable vacuum tank, open to four sides, in that various configurations of nuclear designs can be built and checked.

These reactors are allowed to operate at low levels of heat in power output,

but are not permitted to approach an appreciable power level for safety reasons. The tubes of the reactor can be moved together to move closer to each other, and apart to stop it. In addition, group-loaded control rods are held by electromagnets.

If the operator, viewing the reactor on the television monitor, or on an adjacent control panel, discovers that things are about to get out of hand, he pushes a large red emergency switch. This releases the electromagnets so that the control rods start to move to the position, it also starts the electric motor that operates the helix of the reactor.

#### Test Cells

There are two test cells in the laboratory, each a 48-ft cube built of nonradioactive concrete with walls five to six feet thick.

One Sasep-10 system being developed by P&W, is currently being examined, but its master is the heat-exchanger laboratory. There the major purpose is to test the transfer of heat through two liquid-metal loops, using the cycle developed for the aircraft nuclear engine (loop to loop to air). This cycle work was continued because it was well along in development when the nuclear engine program was canceled last year.

Reactor is situated in the test loop by an electric heater, powered by a 75-volt, 30,000-amp direct current supply.

These extensive laboratory facilities, aimed at the eventual development of nuclear power reactors, are supported by a number of other CANEL facilities, including the shop laboratory, where low-level development tests are performed, and the machine shop itself, with a "cleanroom" atmosphere that meets that of semiconductor fabrication.

Basic work of the shop laboratory lies in the area of metal technology: much of the work on aluminum-cerium alloys and for construction of the loop metal work done here. The shop laboratory develops new processing techniques for these metals and for other phases of nuclear power development.

#### Mechanic Shop Set-up

Machine shop at East glances look like a standard shop, but a clean shop instead of the usually dirty one associated with machining. Floors are shining almost like, stainless look new.

Standard machine tools are used for the most part, but work on refractory metals and alloys is done in a contained, inert atmosphere.

Small parts are welded in boxes filled with argon gas, the welder works through sleeves in the box. For large parts, the welder works in a large room which is sealed and filled with an inert

gas. The craftsman through a tunnel and uses a special tool to cut the access to the room.

While routine, an extensive concern too with a vacuum outside who comes up the cooling in the hot, or to cause the weld current, or handle any other problem that arises. The welder can stay inside for periods up to about ten hours. Welding generally is limited by the amount of argon gas available during a specific time period rather than by any other factor.

These capacities through the core position of the inert atmosphere inside the box and tend to increase the facilities in the wall.

CANEL started in September, 1955,

with the ground-breaking for the Con nection Aircraft Nuclear Engine Laboratory.

The facility was financed with Air Force funds, USAF and the AEC were jointly supporting the development of the aircraft nuclear engine.

That engine development was cancelled in March, 1961, and the work of the laboratory was redirected to the Sasep-10 space nuclear system. The name was changed, keeping the new acronym, in the Government Advanced Nuclear Engineering Laboratory. The facility is government-owned, and operated for the Atomic Energy Commission by Fiat & Whitney Aircraft.



GENERAL ELECTRIC J45 AFTERBURNING SPRAY BAR

## A PRODUCT OF DELAVAN EXPERIENCE

General Electric's J45 turbojet engine is designed to fly about 2000 miles an hour at altitudes between 60,000 and 70,000 feet. This is the Afterburner Spray Bar manufactured by Delavan for use on the J45.

Delavan's 15 years of experience have produced a multitude of fuel nozzles and afterburner spray bars for America's leading aircraft engine manufacturers. This experience

extends to both the design and the large scale manufacture of functional, reliable fuel delivery and metering devices.

Delavan experience: your assurance of quick response to your urgent technical needs, top quality equipment, fast delivery and reasonable prices. Put Delavan experience to work on your engine program now.



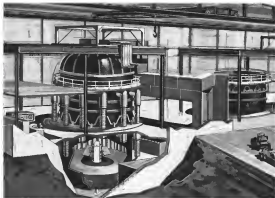
**DELAVAN**  
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**CANEL PROPERTY** shown in this first ever photograph includes 1,100 acres on the bank of the Connecticut River. Facility is operated by Fiat & Whitney.



# NEW SIMULATION LAB



## Nuclear submarine battles give crews realistic training on land



To supply the trained manpower necessary to operate America's first growing fleet of nuclear ballistic missile submarines, Honeywell is modifying the Submarine Attack Trainer facility at New London, Connecticut.

Designed and built for the Navy by Honeywell, the trainer incorporates replicas of the attack centers of three operational nuclear submarines. Through realistic simulation of sonar, radar and message contacts with the "enemy", officers and crewmen are given valuable experience in making combat decisions. The first floor simulates the three attack centers, while on the second floor a Honeywell H-300 solid state digital computer works out tactical solutions to be solved by the officers and crewmen. A command center on the third floor is directed by radio- and voice-aided officers who make strategic and tactical problems and evaluate the trainees' responses.

# DUPLICATES CONDITIONS OF OUTER SPACE

## Honeywell chambers speed spacecraft testing with exact simulation of vacuum, temperature, solar radiation

Scheduled to go into operation next year at NASA's Goddard Space Flight Center is one of the world's most advanced space test and simulation facilities.

The new laboratory will house two test chambers: the Space Environment Simulator (on left) and the Dynamic Test Chamber. These will provide the facilities test and evaluation capability required for flight acceptance tests of the Orbiting Astronomical Observatory, The Space

Environment Simulator will reproduce the high vacuum, temperature and solar radiation conditions encountered in a flight through outer space. The Dynamic Test Chamber will test spacecraft performance under varying air pressures.

Honeywell, as prime contractor, is responsible for design and installation of the two chambers which will permit testing and evaluation without test time due to weather, and at a greatly reduced cost.

*This advertisement is paid for by Honeywell, not the Government. While it is a report concerning deeply with our nation's defense programs, it is primarily addressed to companies seeking help in areas where Honeywell experience can be most useful. Your inquiries are invited. This material has been cleared for publication by the Government agencies and companies concerned. Minneapolis-Honeywell Military Products Group, Minneapolis 5, Minnesota. Sales and service offices in all principal cities of the world.*

## Entomology chamber creates controlled world for insect study

Biologists study the habits of insects and learn more about the life habits of harmful insects and how to control them in a unique environmental chamber, recently completed by Honeywell at its Quartz, California facility for Purdue University.

This comparative behavior chamber measures 8 x 10 x 12 feet and will be housed in the Purdue Entomological Controlled Environment Laboratory.

Equipped with an overhead bank of fluorescent and incandescent lights, the chamber is able to simulate a typical day in which the sun goes through a complete



cycle—from sunrise to sunset.

A Honeywell programming unit provides for automatic or manual control of tem-

perature, humidity, rainfall and illumination conditions—similar to actual field conditions found throughout the world.

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## Military Products Group

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CMC offers solid state standard counters from dc to 1000 Mc with

either vertical or inline nine readout for low and high frequency standards alike. In and as counted input with 1 megahertz input impedance is standard on most models. Coloration, maintenance and trouble shooting operations are fast and simple with CMC counters because all PC boards are plug-in designs. A readout of five internal calibration adjustments makes CMC counters by far the easiest to operate in this respect. The readout is interchangeable with the DDU and does making trouble-shooting only a matter of a simple one-operation DDU replacement.

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2000—1 Mc	F	3,500	7000	0.001—20 Mc	UDT	5,500	7200
40—5 Mc	F	1,800	7000	dc—1000 Mc	F	5,500	7200
40—50 Mc	F	1,800	7000				
1000—10 Mc	F	1,800	7000	0.001 to 10 <sup>6</sup> cps	UDT	1,500	7200
40—50 Mc	F	1,800	7000	0.001 to 10 <sup>6</sup> cps	UDT	5,500	7200

F = Frequency  
UDT = Frequency-Period

UDT = Time Interval Measurement  
UDT = Universal Counter Timer

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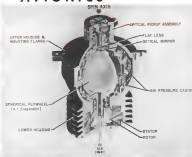
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## AVIONICS



**NEW TYPE NORTH-SEEKING GYRO**, which can determine direction of north to within 30 sec of arc within seven minutes, is shown being operated by inventor, Dr. Fritz Mueller of Aerospace Laboratories. Cutaway (right) shows concentric spheres which form heart of north-seeker. Solid inner sphere is supported on air cushions and moved to zero by action of outer sphere which is driven by electric motor. Entire unit weighs under 50 lb., including thiodolite and power supply.

## North-Seeking Gyro Proves Fast, Accurate

By Philip J. Klein

Basically different type of north-seeking gyro for alignment of mobile vehicle boundaries, which can establish the direction of true north within several minutes, has been developed by Aero-Space Laboratories, Hawthorne, Ala., a subsidiary of Bell Instrument Corp.

Within three minutes after power is applied, the new gyro can determine the true north direction to within 60 sec of arc, or to within 30 sec of arc after an interval of seven minutes, according to the company.

Entire unit, including thiodolite, weighs under 50 lb. and is expected to sell for less than \$10,000 in production quantities.

#### Direct Read-out

New gyro provides a simple direct read-out which does not require the taking of multiple readings and averaging as is the case with previous types of north-seeking.

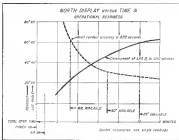
Additionally, the design is relatively insensitive to external vibration and wind gusts, an important consideration for tactical field use.

New gyro is a byproduct of a company-funded program undertaken by Aero-Space Laboratories to design a simple, low-cost, low-drift true gyro

based patent on the new "aplanatic sphere" gives a hold to company vice president Dr. Fritz K. Mueller who conceived the original work in 1955 when

he was deputy director of the guidance and control laboratory of the Army Ballistic Missile Agency.

Man for the new north-seeking gyro



**ACCURACY OF NORTH DETERMINATION** is shown as a function of time after power is applied, based on angle readings. Increased accuracy to be obtained by taking multiple readings. The 10-min. accuracy is shown over six minutes after unit is turned on, with accuracy increasing with time, according to manufacturer.

was the result of an accidental discovery during early tests of a prototype model. Aerospace Ways was told that only those tests that were consistently drilled to the core by a constant angle in run after run, with no apparent mechanical imbalance to explain the effect.

Analysis showed that the gyro spin was holding its position in parallel that when the earth rotated about its own axis, the gyro spin was appeared to an earth-bound observer to be drifting to the east. But an additional correction to be described below, limited the apparent drift angle to a level amplitude,

completing understanding of what was taking place.

Heart of the new north-south is a solid metal sphere inside another sphere which is driven by an electric motor at a speed of 6,000 rpm. When the two spheres have been brought up to speed, at a pressure of about 14 psi, is purged into the 0.001 in. clearance between the two spheres so that the inner sphere now is supported on a thin film of air.

Nominal of the air rotation causes the outer sphere to spin in a relationship with the motor-driven outer sphere. A hole drilled through the center of the

inner sphere, then played at both ends, serves it to spin about the hole as an axis.

When the inner sphere is brought down and balanced, it performs as a near-perfect gyro and attempts to hold its spin axis fixed in space while the outer sphere, being fixed to the earth, will move in a westerly direction in the earth frame.

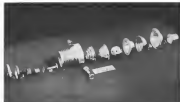
When the outer sphere spin axis is shifted by earth rotation, the vacuum driving torque it produces no longer is applied at right angles to the spin axis of the inner sphere. This sets up torques which cause the inner sphere to precess in the east.

Inner sphere will precess until its velocity of precession just equals the horizontal component of the earth rotation acting on the outer sphere. This sets up a constant angle of displacement in the east between the spin axes of the two spheres.

To determine the direction of true north it is only necessary to measure the direction of the steady state shift of inner sphere spin axis with respect to the outer sphere and then establish a line parallel to the direction of the shift.

To maintain the direction of shift a small mirror is located just the spin axis of the inner sphere with its own self-feeding optical system provided to permit alignment to a theodolite mounted just the external gyro case, shown in the diagram on p. 67.

For north determination, the magnitude of the angle of displacement need not be measured since it is determined by the earth latitude at which the instrument is being used and certain de-



**EXPLODED VIEW** of the sphere within a sphere type gyroscope shows relative low number of parts required. Auto-Space Laboratories, a subsidiary of Bellco Instrument Corp., reports the north-south to sell for under \$10,000 in production quantities.

sign parameters, such as rotational speed and the rate of the outer sphere.

However, the magnitude of the steady state shift angle is important as it does it determines the relative sensitivity of the device which affects the time required to obtain a two-north fix in any desired accuracy. The first model built by Auto-Space Laboratories had a shift angle of seven milliradians at the 80 deg latitude of Hatteras, N.C. But subsequent models have a shift angle almost three times that figure, which reduces correspondingly the overall effect of wobble in the optical read-out and can the true required to obtain a north determination to any desired degree of accuracy or provides higher accuracy for the same reading time.

Complete north-south weighs about 48 lb, including tripod and the power pack which supplies air and 115 v., three-phase electric power. Total power consumption is about 100 watts, d.c., of which 175 watts are consumed by the air supply pump. Power source can be 12 or 24 v. d.c.

Sealed field tests and demonstration indicate that the unit can be installed, placed in operation and the initial two-north readings obtained in about five minutes, according to Andrew George Bellco vice president for planning. That initial reading should be accurate to within 50 sec. of arc. Five minutes later the accuracy will have improved to 30 sec. of arc with a further gradual improvement with time, George explains. If there is time for multiple readings and averaging, accuracies better than 30 sec. of arc can be obtained, company says.

North seeking operation of the new gyro has not diverted Auto-Space Laboratories from its original concept of applying the sphere-within-a-sphere concept to more general types of navigation or its low-drift, relative simplicity of construction and potential low cost.

To date, Bellco, and Auto-Space Laboratories have invented more than a quarter of a million dollars of company funds in observing the design concept. The Navy has awarded a contract to study possible use of the new gyro for an industrial application.

Similar type of non-rotational sphere-within-a-sphere gyro is under development by the TTI Field Laboratory in San Fernando, Calif. Details of the TTI development were reported by Gerald B. Spindel at the Military Electronics Convention in Washington in June.

Because the inner sphere is brought up to speed initially by physical contact with the rotating outer sphere and kept spinning by means that, it need not be made of a magnetic material or with conventional gyro. This permits the use of extremely dense non-magnetic metals, or even non-metal spheres. TTI Field Laboratories, for example, uses an inner sphere made of fused quartz which can be accurately shaped using ordinary lens grinding techniques.

Auto-Space Laboratories conducted extensive tests in its north-seeking gyro over a three-month period in which the gyro was started up and shut down 20 times and a total of 199 readings were made to check on gyro stability and repeatability. After each run, the outer bearing of the instrument was independently measured and the instrument was physically moved to simulate field usage. The gyro and had a steady state shift angle of seven milliradians, making it less sensitive and less accurate than later models designed for a 30 mill shift.

Nevertheless, the one degree demonstration over the 199 readings was 27.5 sec. of arc, while the mean deviation was only 3.8 sec. of arc, according to test data supplied by Aerospace Ways.

Relative simplicity of the new gyro suggests it should have long life and good reliability, company spokesmen say. This is supported by tests in which one gyro was operated for more than 2,000 hr. without signs of adverse wear or malfunction.



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## Air-Flouted Gyro

An air-flouted gyro has spinning sphere, fixed on eight precision gold, nonmagnetic, spaced over rollers. In late stages of development at Anemko Engineering, Inc., 3650 Hillside Ave., Los Angeles, gyro has drift rate of 0.001 deg/hr. employs optical pickup technique.



## Inflatable Antenna Developed

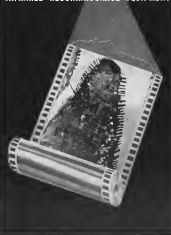
Emergency grab-built inflatable antenna, designed to be stored in deflated condition and deployed, was developed by Goddard Space Corp. under NASA Air Development Center sponsorship. Inside layer of inflated rubber is reinforced to serve as reflector. Radio or radar scans is bounced off internal surface by a solid rotating ball held in center of structure, providing 360-deg scanning.

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## FILTER CENTER

► **New Tech New MDI System**—New wave detector module (MDI) system, which detects gamma radiation emitted by zinc or cadmium tag or ring attached to a missile or shell has been tested successfully by Naval Ordnance Test Station, China Lake, Calif. Target contains scintillator crystal and photomultiplier tube, which provides pulse, proportional to the number of gamma rays emitted by the target. The pulses are transmitted by a ground station which an oscilloscope indicator, wave detector in test. The MDI system made by Electronic Systems Co., San Angeles, are being supplied to NATO and General Dynamics Personnel, in the future, for testing tactical missiles. Range for one reference unit is good between 1 and 10 ft. with a statistical error of 15% between 25 and 50 ft., 10% between 5 and 25 ft. Airborne detection unit weighs 5 lb.

► **An F-4E Recon Satellite**—Reconnaissance—After months of delay, An F-4E Recon Satellite System is finally expected to report reconnaissance proposals within the next several weeks for its modern reconnaissance (Recon) satellite system, a low-altitude, randomly located satellite concept. Proposals for the high-altitude reconnaissance satellite system may be sought next year. Hereafter, The two systems are intended to replace the now defunct Army Air Force satellite program, which was scrapped earlier this year.

► **Laser Modulation and Scanning Program**—Program to investigate the science necessary to modulate at video frequencies and homogeneity and vertically scan the output of a continuous wave visible optical laser will be conducted soon by USAF's Recon Air Development Center. The scanning mechanism to be employed is to permit visibility of at least 100 closures.

► **Optical Switching Effect**—Simple technique for modulating coherent light beams at low megahertz frequencies by switching their deflection angle as a function of deflected signal inputs has been demonstrated by James Woodbridge Dimes of Thompson Research Worldwide. Output of an optical master is passed through a Kerr cell which polarizes light according to a modulating signal applied to the cell. The beams are then deflected by gamma mode of birefringent materials.

► **Navy Accelerates Strike Missile Development**—Navy director of Weapons

is steering funding level for the Strike air-to-ground anti-air missile (SAGAM) known as A-400 being developed by Texas Instruments.

► **Microcomputer for Solar Applications**—Naval Bureau of Ships intends to investigate possible applications for microcomputers in its solar equipment.

► **Command & Control Tradeoffs**—Proposed to explore possible tradeoffs in command and control during launch and may soon be tested by the Office of Naval Research. The proposal was prepared by Space Technology Laboratories.

► **Water Microcomputer**—Way for Intellect and Texas Instruments to announce soon a new line of high-speed microcomputer microcircuits for digital computer applications. Relatively slow speed of presently available unit has been a handicap to computer designers.

► **New Semiconductor Laser**—Semiconductor diode laser (fabricated) from a ternary compound gallium arsenide phosphide, emits coherent radiation in the visible as well as the infrared region previously achieved using gallium-arsenic diode. General Electric scientists report. Research from 6,200 angstroms in the visible region to 8,400 angstroms is determined by choice of materials. An early application of the new type laser is expected to be to provide pump excitation for a ruby or neodymium glass rod laser, according to G.E.'s Semiconductor Products Dept. New type laser appears to have more low conversion efficiency in red-emitting gallium-arsenic diodes.

► **Radiation Resistant Solar Cell Structures**—Research companies are taking a hard look at availability of the silicon radiation resistant N-type solar cell (AW 4, 6, 1963 p. 121) in aspects, how that more earth orbital space is better protected in solar energy may need them to better avoid degradation due to energetic electrons in the interstellar Van Allen radiation belt. National Aeronautics and Space Administration recently announced, then demonstrated a technique requiring the spacecraft construction to match the new solar cells that most spacecraft companies and solar cell suppliers, under NASA guidance see the setback, at least for high altitude earth orbital vehicles, at a considerable budgetary price to have product low costness and degradation of Part N materials with integrated high performance. To date, however, with exception of Telstar (Long Bell Labs) cells, earth orbit vehicles to use applicable quantities in NASA's 5-45 terawatt receiver and an Air Force Mod-

# Recognize these?

Most design and procurement people in the aircraft engine, turbine and rocket fields will have little difficulty in identifying the four turbine components, turbine case and heat sink pictured here. They are quite typical of the hardware of the large engines produced for these and other industries by Taylor Forge.

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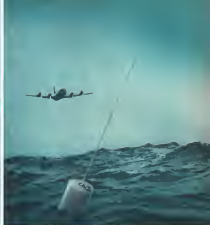
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for use with the Lockheed-built P-3A (P3V) Orion—deadliest combination of man, electronics, and armament ever pitted against submarines.

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tion static and servo modes with visual digital readout accurate to 1.5 arc seconds. **MODEL 252** Air Bearing Test Table— versatile completely integrated test system for guidance systems and components to the 0.001°/hr drift class readouts available with accuracies to 0.06 arc seconds.

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equipment—carrying Ducommun Corporation's order for American and Eastern aircraft. Company also reports Air Force contracts totaling \$974,000 for ground communication equipment for down side tracking stations of the Atlantic Missile Range, and for light detectors and associated computer for aircraft use.

- **Halsdorf Deussen**, of Tucson Electronics System Corp., has small quantities of light efficiency N-aa-P silicon cells available from stock at prices now possible to the next higher efficiency grouping of P-aa-P cells. Delivery of larger quantities depends on quantities and efficiency. Yields on N-aa-P tend to be lower because cells are made with higher resistivity silicon.
- **Hoffman Electronics**, Los Angeles, is in pilot production of N-aa-P cells, has small quantities, in price 10 to 20% higher than P-aa-P depending on efficiency. The higher efficiency cells have a positive price advantage. Company expects to be in full production within next several months.
- **International Rectifier**, El Segundo, Calif., is making the newer cells in small quantity.
- **Texas Instruments**, Dallas, has been producing them in small quantities. The company supplies a suitable order to Lockheed Missiles and Space Co. about a year ago.

• Signed as the Dotted Line—Among major contracts awarded recently by various companies are the following:

- **Eastern Kodak Co.**, Rochester N. Y., will conduct research and development on long wavelength infrared detection under a \$94,497 contract from the Navy Bureau of Weapons.
- **hp Associates**, Palo Alto, Calif., will conduct advanced development as semiconductor vacuum tube under \$130,000 contract from USAF's Advanced Systems Division. A smaller contract, for the same amount, was awarded to Texas Instruments.
- **Spry Aerospace Co.**, Great Neck, N. Y., \$170,000 Air Force contract to produce remote attitude detectors for use in fighter and bomber aircraft.
- **Spry Aerospace** also reports \$13.3 million award from Navy for dual-axis compass to be used on Lafayette class Polaris submarines.
- **Sylvania Electric**, Mountain View, Calif., \$2 million contract for development and production of security equipment to be used at Minuteman ICBM bases.
- **General Precision**, GPR, Division, Pleasantville, N. Y., will build an lightweight AN/APN 151(V) Doppler navigation systems for Bureau of Naval Weapons.
- **Westinghouse Electric**, Tube Division, will develop a 91 line (pic) aerial inspection and measure displacer under two Army Signal Corps contracts totaling \$29,304.
- **Collins Radio Co.**, Cedar Rapids, Iowa, reports contract for about \$1 million from Boeing for light detector systems to be used on new 737 jet

airports on order by American and Eastern aircraft. Company also reports Air Force contracts totaling \$974,000 for ground communication equipment for down side tracking stations of the Atlantic Missile Range, and for light detectors and associated computer for aircraft use.

- **Matco**, Military Electronics Division, Scottsdale, Ariz., will develop digital command (data link) system for the Gemini two-man space capsule under contract to McDonnell Aircraft Corp.
- **North American Aerospace Division**, 541 million lines New York production of submarine inertial navigation systems (SINS) for installation on 10 new Lafayette class Polaris submarines. The 10 contract was Mark 2, Mod 2 type. The award makes Aerotek the SINS supplier for 24 of 29 Polaris submarines scheduled to date.
- **Roll Aerospace Co.**, Buffalo, 549 million to design and build active radio command control system for Army SD-1 force aircraft.
- **Long-Texas-Vought**, Dallas, \$75,000 contract from Bureau of Naval Weapons to study construction planning techniques for use in military aircraft structural systems. The 18 month study will include analysis of military aircraft structural system to determine where the construction techniques can be employed.



### High Power Klystron

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## NEW AVIONIC PRODUCTS



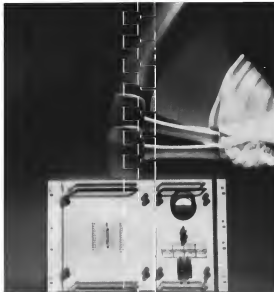
• **Ministar** chips, Type 78A, operate from 20 to 700 cps and volt direct source over temperature ranges of -60C to 175C and withstand vibration of 50 g from 5 to 200 cps, according to manufacturer. Counts are 8192 configuration, rated 1 ms at 10 v. Unit is packaged for printed circuit board mounting, measures 5 x 11 x 11 in weight 9 g. Manufacturer: U S Electronics Corp 380 Mt Lebanon Blvd., Pittsburgh 34, Pa.

• **Measurement** coaxial cable, suitable for operation at 200C temperature, and fluorinated ethylene propylene/dielectric which gives it a capacitance of 15 picofarads per foot for 91-ohm cables. Manufacturer: Microdot Inc., 220 Pasadena Ave., South Pasadena, Calif.

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• **Rubidium frequency standard**, Model 3918, provides long-term stability of 6 in. parts in 100 billion over a 90-day period with short-term stability of one part in 100 billion according to manufacturer. Output is at 100 kHz, 1 mV and 5 mV. Unit weighs 35 lb, occupies 6 1/2 cu ft. Manufacturer: General Technology Corp., 3510 Townsend Blvd., Torrance, Calif.



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packaged; the power supply is separable and modules may be rearranged to suit system requirements. This rugged, reliable memory comes from Ampex Computer Products Co., Culver City, Calif. A division of the only

company providing recorders, tape and core memory devices for every application. Ampex Corporation, 934 Charter Street, Redwood City, California. Sales and service throughout the world. Term financing and leasing are available.



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SURIC—Surface Ship Integrated Control—will soon provide “hands off” control of destroyers and other vessels, displaying all functions in consoles on the bridge.

On Polaris-firing submarines, Sperry is navigation systems manager. Sperry SINS (Ship's Inertial Navigation System) equipment provides a continuous record of dis-

tance traveled, direction, ship's position, pitch and roll and every other critical motion—then supplies all navigational data for the exacting job of aiming the Polaris itself. Other Sperry sea systems range from periscope optics to passive underwater detection for ASW... from diving, steering and depth-keeping controls to the Celestial Altitude Recorder that focuses on the stars.

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# Advanced Transistor Production to Begin

By Barry Miller

Luminate, Cold-Pilot production line capable of turning out a family of five types of high-power transistors which may make possible seventh subminiature High Power (HPT) air force transistors is expected to be in operation late this month.

Working for the part cost and a ball order an \$800,000 methods development contract from USAF's Personnel Systems Division, TRW Electronics, San Pacific Semiconductor, Inc., now plans to produce the first of five different types of epitaxial transistors in a single line.

System will use a minimum amount of common equipment for all transistor types. The effort is sponsored by the Manufacturing Technology Laboratory of ASD's Electronics Division.

Sample devices fabricated under this program have been delivered to ASD and distributed to Air Force application engineers. One interesting potential application for the transistor is their use in the increasing use of coherent transistors in output devices, replacing tubes.

Air Force is interested in manufacturing methods for the devices and the pilot line, and samples will provide it with a measure of substitution performance, according to USAF Lt. T. W. Brady, project engineer on the methods development contract.

Three basic package types were developed for the five silicon transistor types which are planar epitaxial devices rated from 1 to 100 amp. The five types are:

- 200 amp. transistor capable of delivering 700 w at 70 sec with a power gain of 90 db at a maximum efficiency of 45%. This device is packaged in an all-cold welded copper enclosure using ceramic tube and designed for use in air cooling. Details of this type have been fabricated, but in the absence of suitable power-measuring equipment, have not been tested. Package uses it is expected that the device will meet its specifications, as it is made in an all-cold welded in lower current types in this program except for the cooling factor. The package is 21 in. in dia., and not including legs, measures 11 in. in height. It is mounted on a 4 in. 25/32 sq. in. base.

- 50 amp. transistor designed to deliver 100 w at 20 sec with 10 db power gain at an efficiency of 40%. This device uses the same package as the 100 amp. transistor and also has been tested. The package shown in an accompanying photograph, complete dual emitter leads which eliminate

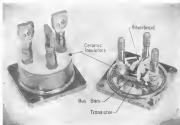
metal coupling between input and output circuits in common emitter configurations. Typical improvement in gain made possible in using dual emitter was 5 db measured on 50 and 10 amp devices, according to Ronald Key, project head of transistor development at Pacific Semiconductor. The dual emitter also tends to boost efficiency, increasing at high frequencies.

- 20 amp. transistor has delivered 125 w at 25 sec with 10 db gain and 60% collector efficiency. The package for this device measures 1 in. in height, 1.6 in. across its base and 1.1 in. in height including its stud.

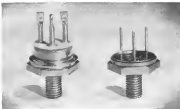
- 20 amp. device has delivered 60 w at 10 sec with 10 db power gain. This transistor uses the same package as the 20 amp. device.

- 1 amp. transistor has delivered 10 w at 100 sec with 10 db gain. This package measures 1 in. from base to lead across its base and 1 in. in package height with another 1 in. for its stud.

Fabrication of high power, high frequency transistors is a particularly difficult task, requiring many of the normally troublesome problems in transistor fabrication. The basic semiconductor device from which the transistor



ABOVE ARE VIEWS OF THE 100-AMP, 20-sec. silicon transistor which is expected to be able to deliver 700 w at 70 sec with a power gain of 90 db at a maximum efficiency of 45%. High power transistor is one of five types that are to be produced in pilot production line scheduled to go into operation at TRW Electronics/Pacific Semiconductor, Inc., later this month. At left is 200 amp. cold welded copper enclosure. Three terminal legs are for dual emitter to eliminate metal coupling between input and output signals.



TRANSISTOR PACKAGE for 10 and 20 amp devices capable of delivering 60 and 125 w at 10 and 25 sec, respectively, is shown above.

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is made need be increased in size to increase output power, but this tends to increase capacity, thereby cutting the frequency.

The frequency, in turn, can be increased by reducing base thickness of the transducer so that size is traded for base thickness.

The typical base thickness for the 100 amp device is between 1 and 1.2 inches.

Since the size of the die is larger than in small signal transducers, the chances of contamination increase.

This process leaves demands on refining fabrication processes to offset the likelihood of low yields in the production phase.

### Fabricating Process

In fabricating the transducer, the semiconductor substrates are purchased out-of-house, their faces lapped and polished and collector regions optimally grown.

The company claims to have developed a protection method for what previously was called a laboratory electrochemical polishing procedure. Semiconductor wafers are chemically polished by the action of a weak and electrolyte through which current is passed.

Series of largely conventional processing operations follows with exception of a base diffusion creating vapor deposition of the impurity metal. Once diffusion steps are passed and metal contacts etched to base and emitter, the semiconductor are dried.

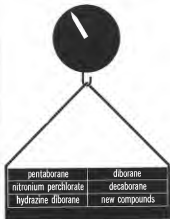
At this point the dies are placed in different jigs, depending on the size of the final device and features associated to their respective burden. The 1-amp device is handled slightly differently from the other transducers and its leads are then thermal compression bonded. In the larger devices, leads are attached by soldering. Finally the devices are capped.

### Other Work

In addition to its work on the Air Force contract, Pacific is conducting other efforts on high-power devices under the sponsorship of the Army Signal Corps.

These include:

- 5 watt, 70 sec. (28 volt) device scheduled to enter into pilot run this spring. This device uses a boron oxide tube on which the transducer is mounted so that the heater is isolated from the transducer. This permits direct coupling with the collector at other than ground potential.
- 25 watt, 100-sec. device for which research and development contract is now being completed and a follow-on production engineering research contract for a 75 watt business has been awarded.



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## ALLOY NOMENCLATURE

1. Table 1—Nomenclature of Aluminum Powder Metallurgy Alloys

Way	Old description	Ratio
XAP001	M57	6
XAP002	M55 & M58	8
XAP003	M70	11
XAP004	M32	14
XAP005	—	6

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3. Table 18—XAP001 Extrusions, Minimum Mechanical Properties

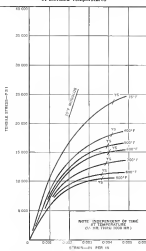
	Longitudinal	Transverse
Epistemic (Strong ID)	17/100	30/100
Practical (Strong ID)	20/100	17/100
Epistemic % at 0.0	17	7
<b>Self-P</b>		
	Longitudinal	Transverse
Epistemic (Strong ID)	14/100	14/100
Practical (Strong ID)	13/100	9/100
Epistemic % at 0.0	14	9
<b>Self-P</b>		
	Longitudinal	Transverse
Epistemic (Strong ID)	9/100	Not available
Practical (Strong ID)	6/100	Not available
Epistemic % at 0.0	9	Not available

#### 4. Table IV—Physical Properties of Alcoa's APM Alloys

[illegible]

Tests made at Egan Research Laboratories in 2000-2003 (AP001 and AP004) have shown that Penta allows less 1,7'-2' lumen to reach during curing as other less weight aluminum effect. Added products also extend viscosity high during curing.

### 5. Tensile Stress—Strain Curves for Alloy XAP001 at Elevated Temperatures



## ARM PRODUCTS

2. Table II—APM Product Chart

A—Products have been fabricated on a production

Alloy	Sheet	Plate	Pipe/tube	Extruded sections	Extruded sheet	Extruded tube	Fasteners
BAPO001	X	X	X	X	X	X	X
BAPO02	X	X	X	X	X		
BAPO03	X	X	X	X	X		
BAPO04			X		X		
BAPO05	X	X	X	X	X	X	X

Alcoa recently has developed a series of new high-temperature (900°F to 1,000°F) alloys made from aluminum powder. These remarkable Aluminum Powder Metallurgy (APM) Alloys have higher mechanical properties at these temperatures than any other aluminum alloy.

Alcoa's Aluminum Powder Metallurgy Alloys also exhibit several other attractive characteristics including:

- Stable properties at temperatures regardless of the length of exposure time at temperature
- Retention of original room temperature properties and dimensions after repeated elevated temperature exposures
- High modulus of elasticity at both room and elevated temperatures
- Strength without heat treatment. All APM alloys are used in the as-fabricated condition
- Low neutron capture cross section and rapid decay of induced radioactivity

Take Alloy XAP00 for example. Check its minimum mechanical properties in Table 3 reprinted from Alcoa's Development Division Report. (This is the first time minimum mechanical properties have ever been published for any al-

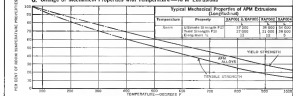
nomous alloy strengthens up to and including 300°F.) In addition, XAP001 has corrosion resistance comparable to 6061-T6 and is immune to stress-corrosion cracking. It has been ultrasonically spot welded, flush-butt welded and cathodic bonded to steel and other aluminum alloys. Alcoa's Aluminum Alloy XAP001 can be spun, machined with a minimum of tool wear, and modified, hydrocycled or plated.

XAP901 is available in rods, forgings, extrusions, tubes, sheets and plates—write us for procurement specifications on any of these items. Consider APM alloys for such applications as reactor core components, valves, pistons, piston rings, hydraulic and bearing equipment, and all engine accessories.

XAPROS contains catchwords similar to XAPROS but was developed for nuclear reactor applications.

Though extensive design information on KAP001, as well as on APN alloys KAP002, KAP003, KAP004, and KAP005, is already available, Alcoa will continue, as always, to investigate new APN alloys, new processes and improvements. Please keep in touch with us for current information.

#### 6. Change of Mechanical Properties with Temperature—APM Extension



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## Mergers and Acquisitions

**Powertec** a **Ultrasonics Corp.**, of Flushing, N. Y., has consolidated with **Gascon Controls Corp.**, of Duarte, Calif., and is operating as a wholly owned subsidiary. **Powertec** handles equipment for muscle fact inhibition system, loading and unloading controls, submersible depth measuring devices and other systems involving control of fluids.

Kellett Aircraft Corp. has bought a controlling interest in J & K Precision Tools, Inc., of Lancaster, Lexington, Pa. J & K will operate as a Kellett division manufacturing precision tools for the toolmaking industry. Production and sales will continue to be handled at the Lancaster plant with purchasing and other business being handled by the Kellett office.

National Union Electric Corp., a diversified industrial corporation, has acquired 71% of the common stock of Burt Electronics, Inc., a research firm specializing in aerial communications and surveillance, space and missile communications, and digital and radio systems. Purchase was for an undisclosed amount of cash. Burt will be operated as a subsidiary of National Union Electric.



### Canadians Use Aircraft Radar Tester

**Kwik test** in CP104, Canadian version of the F164 built by Canfax, Ltd., is housed in trailer. Airtight nose and refuse are inserted into rear of trailer containing an overhead chamber to permit full rotor operation and revolution. Residue control stands, shown to right of cockpit, enables operator to conduct tests while wearing night-vision goggles. The ETS-104C roller tester is built by Krombach, Inc., Santa Monica, under \$115,000 contract with Canfax.

## PRODUCTION BRIEFING

Burtek, Inc., a subsidiary of Dorset Electronics, Inc., Tulsa, Okla. has received the first training equipment purchase order for the Boeing 717 program. Burtek will provide assembled, built-to-print test fixtures for the medium-range jet transport's air-conditioning, pressurization, hydraulic, electrical and fuel systems. Orders were placed by United Air Lines, which will take initial delivery of the 717 transport late next year.

**Space Road Corp's** Valiant Division will develop an integrated public mobile life 60-kil, thrust chamber to power specific design concepts for bi-propellant rocket control systems. Programs sponsored by National Aeronautics and Space Administration will include design, fabrication and development phases of a prototype bi-propellant engine and test chamber. Apollo, Gemini and the Lunar Traction Module are among vehicles which will require bi-propellant rocket control system.

Hughes Aircraft Co. will build electronic data analysis systems under a \$27.610,000 contract from Boeing Co., which will indicate readiness of Air Force's Minuteman ICBM prior to launch and will signal when missiles have to be launched.

Allison Division of General Motors has been awarded a \$10,355,000 contract from Aerojet-General Corp. for continued production of titanium second-stage rocket motor cases for Air Force's Minuteman ICBM. Allison also has been awarded a \$1,297,375 contract for development of a case to be utilized with an advanced version of Minuteman.

Bender Corp. is building a new system that will help locate tracking ships. The location of some owners is in development packages which land in sea. Since the system is Ship-Tended Autonomous Recovery (STAR) is being deployed under a \$1 million Air Force contract. It is the first to use acoustic data transmission techniques for exact location, rather than using cables attached to shore-based receivers.

Block Instrument Corp., College Point, N. Y., a full contract developer, of an edometric recognition system for the ground leaching (chalc) of Asar's surface-to-surface Mender nozzle. Block was selected as a competition result, ranked by General Dynamics Research (AG) Oct. 1, p. 13).

**manager**

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## PROBLEMATICAL RECREATIONS 149



A cubic box with sides  $a$  feet long is placed flat against a wall. A ladder  $p$  feet long is placed in such a way that it touches the wall as well as the free horizontal edge of the box. If  $a = 1$  and  $p = \sqrt{13}$ , calculate at what height the ladder touches the wall.  
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Controlled

Ken Jr., Merry Rasmussen, for this message to all readers. Your large response to this series during the year has warmed our hearts and delighted our heads. We thank you all. May we at Litter Industries extend our wish to you for a glorious holiday season and most propitious new year. May we also hope you will continue to solve the puzzles in 1983.

ANSWER TO LAST WEEK'S PROBLEM:  $\frac{97.526}{19.816} = 5$  or  $\frac{75.349}{15.061} = 5$

$$\text{or } \frac{57,429}{165,341} = 3$$

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# AERONAUTICAL ENGINEERING



HEAVILY RETOUCHER PHOTOGRAPH shows the Mi-3 prototype of Hindustan Aeronautics' HF-24 jet fighter in flight. Flight testing of the prototype has been under way with Indian air force pilots at the controls since June, 1961. Mi-3, powered by two Bristol Siddeley Olympus 725 turbojets, has a top speed that equals the supersonic engine. Planned Mark 2 version is scheduled to be powered by two Soviet perovskite-dugated RD9F. Photograph's setting is about the same as Bristol Siddeley's Olympus 72.

## India Spurs Domestic Aircraft Industry

By Cecil Braverman

New Delhi—India's domestic aircraft industry now is attempting to gain for a major leap forward: basic technological and financial, in a model of the recent Soviet-Indian border area.

The concept, which has moved past initial Indian tests in the related recognition that India must develop a local base defense production capability, also is providing its share of technical aid, including the necessity of establishing a list of priority requirements on an accelerated basis, need of creating new support industries contemplated here and a long-range appraisal of Soviet intentions.

### Soviet Commitment

On immediate concern is less for Russia aircraft, but to go toward meeting all of its pre-emptive requirements which are being related upon to open new technological sites as well as provide additional and much needed production facilities.

Prime Minister Jawahar Nehru and new Defense Minister Y. B. Chavan, regarded here as a political realist, have agreed previously that the Soviet plan to meet their commitments (AW Nov 19, p. 38 Dec 10 p. 31). These are still under discussion, as in the fact that the Soviet will fulfill these promises to provide India with advanced production facilities in the near future.

Some already believe that, in this respect at least, Russia will attempt to move slowly to join in the border de-

pendent with Communist China, whereas an open issue with the probability of a second conflict. For each conflict could seriously affect two of the country's most ambitious projects within the area now open.

### MIG-21 Fighter

Last year the plan to build the Mark 2 MIG-21 aircraft Soviet designer order India was dropped. Progress was made in providing India with a threefold general purpose aircraft production base, a large boost in technology, particularly in fabrication of various components plus a modern aircraft for the air force.

Technically, at least for the moment, is India's plan to build a Mark 2 intercepter variant of Hindustan Aeronautics' HF-24 jet fighter. Mark 2 version will have a new design speed within the Mark 2 range, is currently designed to be powered by two Soviet turbojet powerplants.

Indian officials here are reluctant to reveal details of the Soviet engine and will go to the Soviet for a 30-day official Russian description RD9F. It is known, however, that the perovskite has been in operational service under the Eastern line for a number of years and that its nature is approximately the same as that of Bristol Siddeley's Olympus 72 which had a thrust design thrust of 13,100 lb.

Emergency also has forced a decision in the country's increased production program for the new 748 which is scheduled to replace the old average Deag-

ler DG-5 and a transport capacity for both the air force and the government-owned Indian Airlines Corp.

In a move to develop in production potential centered at Hindustan Aeronautics' plant at Bangalore in southern India, the government decided to have the 748 manufactured at Kompar between New Delhi and Calcutta at the sprawling headquarters of the air force's maintenance command. The first Indian prototype of a Series 1 model will roll out from there this year.

### Kompar Facilities

New layout the Kompar facilities and facilities are situated about 100 miles north of the day-to-day task of maintaining, inspecting and repairing the air force transport fleet which is being a heavy schedule in logistics support of Indian army units located along the stretched Hindustan border area of Ladakh and the North East Frontier Agency.

Due to the dearth of surface transport facilities within this mountainous area, these topography flights probably will have to be continued so long as the army remains there.

Indian air force fighter speed runs also are training in an accelerated pace, and 748 production is suffering accordingly.

Under original government plans, a portion of the mountainous command facility eventually will be light oil, gas or an appropriate fuel and designed as a normal source of primary aircraft production.

The planned third source in the capital building was to be the MIG-21 plant scheduled for construction in China on the east coast of India south of Calcutta. Defense industry planners will hope such a plant will be established—not for the MIG-21, then for a possible U.S. or British counterpart.

Other hoped-for Western production requirements with the West probably also will limit the number of production facilities located there.

Construction of a separate plant for new production could be a political necessity as well as a natural advantage in many cases. In one respect, at least, U.S., British and Russian zones, an official position—an assurance that no production of their respective military equipment be conducted in facilities separate and apart from those leading to the border from areas of another political scope.

### HF-24 Production

Production plans for the HF-24 also are being conducted in the area of a new defense, as typical Indian planners are to establish equipment priorities in line with immediate requirements and capabilities.

Production is possible. Although its technology is not in the field, officials here are not anxious to the about any small doubt that commands are defense production decisions, i.e., the point at

which to distribute, despite open or closed that which is not completed to search and development projects or possible technological programs in such areas, however.

Second reaction to this is around the fact that Hindustan also is a producer of various, and in this respect, need for some logistics support. Down on just how to split the government-owned Soviet production between various and into a new unit must be made.

Present plans call for the HF-24 to be built in two versions, the Mark 2 intercepter and the basic intercepter Mark 1 prototype, in a Bristol Siddeley Olympus 725 turbojet of 4,520 lb. thrust. A Mark 1 prototype of which has been flying since June, 1961, would be used primarily for close support. Work on the intercepter model began in 1955 under the leadership of Dr. K. T. Rao, a leading World War 2 engineer who served during at Germany's Focke-Wulf.

Mark 2 version has been scheduled to be produced by the Olympus 725, but that project was dropped in Great Britain because of lack of funding and an inherent development of such requirements in that area. India turned to the Soviet Union after Bristol Siddeley estimated that a small speed, an adaption of 500 lb. to complete development of the Olympus 725.

Installation of the RD9F in the

existing engine, which might mean action requires alteration of the engine packages along the course of the Soviet engine. Indian agreed to meet this, the engine used, then, but, there has been an indication that work on this has been discontinued. Three projects also is a little evidence that it has begun.

Consistent with its technical capabilities, Hindustan Aeronautics has been developing a strong production team, although because of political considerations, the limited production program for the RD9F was scheduled for Great Britain. However, the Bangalore plant will become some contractor at the limited production program for the 748 jet. Hindustan Aeronautics while Indian, principally designed to power a variety of Soviet aircraft 3 helicopters in the Indian air force.

### Aluminum Airframe

Government also may avoid Hindustan the limited production contract for the Aluminex airframe, but no decision on this front has yet been made. Before this, project concerning Kompar has been a great obstacle for the air force project.

Production of the production at Bangalore include the Olympus 725 for the close-support version of the HF-24, the Olympus 701 for the Hindustan-made Folland Gnat lightweight fighter,



## Vertol 107 Scheduled for RCAF Delivery in March

First of six Vertol V-107 helicopters for the Royal Canadian Air Force is shown during recent winged flight outside World Development Plant, Vernon, B.C. Scheduled delivery date for this aircraft is March 1962. Helicopter designated CH-113 by the RCAF, will be used on search and rescue missions. Balance of the order is in various stages of assembly. The 107, shown above, is at RCAF Air Force Base, where it currently is undergoing climatic testing. RCAF 107s have special provisions for climate control and for fuel heating in line with the helicopter's intended rescue missions.

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Series 1 version of the T48 powered by two Dart B.Ds. 6 engines of 1,740 c.hp. each does not have the high altitude performance required by the air force for its operations into the Himalayas and only four aircraft of this version are scheduled to be built at Kinnaird.

After completion of these four, Kuwait is to begin work on an extension to the Series 2 model which was recently certified in England. Air Force also has a requirement for between 40-50 MFT48 (single), variant, and the government is expected to follow through with negotiations for licensed production of this combat aircraft.

While the government moves to expand its reform-regime production base, it is becoming increasingly evident that support industries also must be developed on an accelerated timetable if the country is to have a truly domestic machine manufacturing capability.

At present all the basic materials must be imported, down to the nuts and bolts. India has no production capacity in this area, although it is now considering, as a first step, establishment of two plants with foreign aid for the production of aluminum extru-

"We are not building a supersonic aircraft," one official emphasizes, "when we have to hang in there until they just give up." "We're not producing — we're actually assembling."

Debate with which the government has seduced aircraft and helicopters from both East and West as part and parcel of its counterinsurgency policy—these are reported. If different bugs in the air force inventory—possibly an added vision all around, particularly in assessing adequate support, and suggest that sooner or later India must give some thought to at least partial state withdrawal. At the moment, this is not possible, and it places an added burden upon defence planners to not decide what to build and what to maintain.

Roberts, thus far, also has been plagued by a paucity of funding for actual defense items and, since financial support and active Defense Ministry encouragement were available here, limited to production of such products as chlorine sulfur pots, bus choppers, pressure cookers, the propeller and, on the other end of the scale, Hindustan Aircraft's rotary engine.

teachers and undoubtedly called an Indira drive toward a better living for its people. It also reflected official policy of largely ignoring the masses, and the machines used for the manufacture of coffee pots cannot easily be turned to defense.

In an effort to offset this shortcoming somewhat, at this relatively late date, the Defense Ministry has drafted a list of its defense tool needs on an increased priority basis. The list is now being circulated among the industrialized nations of the world, East and West, who may or may not come to India's aid. The major portion of help, however, is expected from the U.S.

Capability of producing airborne and ground electronic systems is a glaring need—almost all the subcontracts for licensed products are now imported—and one that has been overlooked. As an example, a licensed production contract signed by the government with Bendis approximately two years ago has been largely ignored since the (AW Nov. 28, p. 33).

Despite this, there has been a boom. The government established Buntel Elektroden AG (B.E.L.A.), near Bamberg in 1974 and, under the technical supervision of Fischer's *Chemische Gesamtleitung* Telegrapher, now FE, this firm has been slowly developing its capability. To date, however, its production has been geared almost solely to good units, including single carbon-carbon rectifiers and transmission on the new band, transmission rectifiers and "willer-tiller" on the spot.

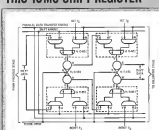
Hindustan Aircraft, on the other hand is an enterprise from British rule (established in 1940), it assembled Hawker warplanes and C-47 lighters throughout most of World War II.

After the war, it converted to primarily an engine-airframe repair and overhaul facility, until the new Indian government decided that, as a matter of national policy, it should become strictly involved in original aircraft design and production.

First step was the HT-2, an all-metal beam tractor which made its first flight in August, 1951. It remained in production for almost 20 years to meet the requirements of the *de force*, navy and private flying clubs. The HT-2s also were sold to China.

Two more light models of domestic design were subsequently brought out and are still in production—the post-war Fulguro, arête, plane and a four-wheel follow-on designated the Kodak. The company stepped into the mass market of large, more advanced aircraft in the 1950s with the licensed production of the de Havilland Vampire jet fighter. The Canard then the HF 34 followed on the line.

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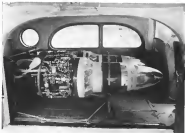
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FIRST OF TWO Turbo Porters ordered by Waco Alaska Airlines is scheduled for delivery by the end of the year. Waco already was the passenger Porter tester.



CARGO CAPACITY (above) is shown by loading two Turbomeca Astromec engines. Standard wheels (below) can be replaced by conventional ones for landing on unpaved strips.



ASSEMBLY LINE for DC-6 Porter light utility

aircraft is shown at the plant of Pilatus Aircraft Works, Ltd., Stans, Switzerland. Turboprop version is being flight tested.

## Pilatus Turbo Porter Undergoes FAA-Required Changes

By Edith Waldorf

Stans, Switzerland—Seven multi-part Turbo Porter with improved STOL capabilities, latest version in the Pilatus Porter PC-6 (AW) (see 11, p. 304) light aircraft were built by Pilatus Aircraft Works, Ltd., here, in undergoing several minor changes to meet Federal Aviation Agency requirements.

In addition to the alterations, design equipment is being fitted to the propeller spinner of the aircraft and its fuselage-mounted kit detector replaced by an FAA-approved type. After modification, the aircraft will receive flight tests prior to its FAA certification, which is expected within a few weeks. According to the company's managing director, Hans F. Althoff.

The changes, the Porter was fitted with a larger, retractable tail wheel, soon to become a standard feature at both the piston engine and turboprop-powered versions and specifically designed to enable the aircraft to land on and take off from soft grass or other unpaved surfaces.

As an optional extra, larger, low-pressure, 11 in. by 12 in. dual main landing gear wheels also are available. Using the same landing system in the standard 71 in. by 10 in. dual type, this version can be fitted to replace it within a few minutes.

At an altitude of 15,000 ft., the Turbo Porter can operate at a true airspeed of 110 mph with only a slight decrease in the cruise speed. With a payload of 2,500 lb. over a range of 650 stat. mi., fuel consumption is 129 U.S. gal.

The 382 hp additional power provided by its Turbomeca Astromec 3 STD engine (using a three-blade reversible propeller, enables the Turbo Porter to climb to an altitude of 10,000 ft. from takeoff within 3 min. Rate of climb is 1,500 ft./min.

According to latest Air Transport Asia figures, operating costs of the standard version compare favorably with other piston aircraft being and for both service and single multi-purpose duty. Porter costs \$55,000 per aircraft including.

Price of the Turbo Porter, including standard accessories, is \$65,000 (TAT).

The piston engine Porter fitted with a repositioned 350-hp Lycoming powerplant sells for about \$45,000.

Present production rate here is three aircraft per month, but the company could handle up to twice as many if necessary.

It also would be possible to the plane's metal-structure units before it entered its final assembly. At the moment, Pilatus is negotiating an initial Porter license production agreement with Officine Aeronautiche, of Venice. If the agreement is signed within the next few months, the Italian-produced aircraft will be designated and marketed in Italy as the Avioport.

According to Althoff, Indian manufacturers may be the next to apply for production rights to the Porter aircraft. Five Lycoming-powered models sold to India have been going good service there for some time, particularly in Nepal, he said, and Indian authorities are showing interest in acquiring several Turbo Porters, possibly for use in military transports. A firm order for these has not been received, however.

Reports that India is negotiating with Turbomeca S. A. at Barden for production rights to the Turbomeca Astromec 3 turbine engine, which powers the Sud Aviation Alouette helicopter, have been confirmed by the French company.

First two of an undisclosed number of Alouette helicopters also were recently delivered to India. According to Althoff, it is reasonable that India will later apply for the production rights to the Porter as frame but also to its Astromec engine in a next step in the Turbomeca engine series manufacturing program in India.

Following introduction of the Porter prototype at the 1970 Paris Air Show (AW June 15, 1970, p. 301), 43 aircraft have been built, of which 33 were fitted with single 375-hp Lycoming engines and the remaining 10 with uppositioned 350-hp Lycoming powerplants.

Except for 11 sold domestically, those used by the company for demonstration purposes and one or two retained by Pilatus in reserve aircraft, they have all gone to 55 airlines from Alaska, Finland, Sweden, Holland, West Germany, France, Algeria, the Sudan, West Africa and Nepal.

About a score of aircraft sales have to North and South America, Africa, Asia



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### FAA Completes Transport Arresting Tests

Federal Aviation Agency has completed its latest series of transport arresting gear tests with successful wind-tunnel and 250,000 lb. King 720 transport (tail-on) involving 126 lb. FAA is now evaluating the results and expects its evaluation to be completed by the end of the year, although deadline is April, 1963. FAA's 720 was arrested 19 times for tests conducted at the NASA's Ames Research Experimental Center (NAFEC), Edwards City Center C-130 was caught 18 times. Top arrest speed in the tests was 130 kt, tails a combined weight of 215,000 lb. Arresting equipment was manufactured by GE Aviation Engineering Co., Wilmington, Del., under S1 contract FAA contract (AFW-July 9, p. 18).

use of the present facilities for both the Porter as well as Menzies production lines.

- Production of wings for the new graded Moquitto cascade which is built in the Swiss Contraves-Clémentine concern.
- Overhaul of Pilatus P-3 two-seat trainer under order for the Swiss air force.
- Maintenance of de Havilland Venom two-seat, all-weather fighter. The de Havilland fighter also is in Swiss air force service.
- Maintenance and repair on Douglas DC-3 transports for Swissair in addition to private aircraft for sport flying.

### PRIVATE LINES

New certification and reporting standards have been proposed by the Federal Aviation Agency for agricultural aircraft operations. Under the new proposed regulations, each aircraft operator would be responsible for reliable, reliable reporting of aircraft.

Largest single order for business airplanes ever purchased by Swiss Aircraft Co.'s International Sales Dept., covering 40 aircraft having a total value of over \$1 million, has been placed by Miles King, director of distribution in Australia and New Zealand.

### STRUCTURES AND DYNAMIC TEST ENGINEERS FOR ADVANCED MISSILES AND SPACECRAFT

University of California, Berkeley, is seeking a variety of high-level aerospace engineers and scientists to work on a variety of projects for the Department of Defense.

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# Bendix Completing Arms Control Studies

By Ward Wright

Ann Arbor, Mich.—First of a series of contract studies laying groundwork for possible U.S. participation in an international arms control agreement is nearing completion at Bendix Systems Division here.

The study, a \$150,000 contract awarded by the U.S. Arms Control and Disarmament Agency (ACDA), last February (AW Feb. 12, p. 17), covers development of techniques to monitor production of strategic delivery vehicles, including ICBMs, IRBMs, air-breathing missiles and assorted homelers.

Monitoring techniques would be applied from the perspective of two entities, through queries, testing of the finished product. Development of hardware for monitoring was not included in the study.

In another study, Bendix and the

University of Michigan (acting as co-third subcontractor) are working under a \$95,000 Arms Control Agency contract, awarded last June, to study verification requirements of any disarmament treaty the U.S. might enter into. As part of this study, an overall listing of possible treaty violations both as to intent and letter of the law will be made. Both studies are due for completion by January 1963.

In studying problems connected with monitoring strategic aircraft and missile production, Phil E. Chase, Bendix arms control and disarmament program director, said three aspects of production must be considered:

- Critical hardware and air materials
- Unique manufacturing processes and tools
- Capital equipment—Standard types of production and test equipment, frequently expensive, that can be con-

verted to produce strategic hardware with little or no alteration.

Early in the study, Bendix, issued major U.S. aircraft and missile plants to catalog critical hardware and unique items common to these industries. In addition, unique manufacturing processes, including the need for specialized tools jigs and dies, were also cataloged, as was capital equipment.

In analyzing these components, Bendix will outline manufacturing techniques, based on observable physical characteristics, to be applied to two broad areas: dedicated facilities and undedicated facilities.

Dedicated facilities, such as factories, assembly plants, raw material and power sources are inseparable to a number of types of missile, on-site, and inspection team monitoring that could expose clandestine production.

For instance, a nuclear reactor anal-

be closed to detect any change in components normally found in the atomic plant of a given area, thereby giving warning of a string of change in production in the vicinity. Similarly, system monitoring of those facilities could detect changes in components, indicating different manufacturing processes, such as heat-treating, were taking place. In both cases, an inspection team, under this study, would be in a follow-up inspection.

Other missile sources might include enhanced TV cameras scanning the sky for telltale smoke, streamers left by rocket test firings, or vapor trails left by strategic launchers.

## On-Site Monitoring

In on-site monitoring, TV cameras could be used to keep watch in the factory or be moved to test or more open the critical operations such as welding or metal forming, to determine whether any deviation from normal production were taking place. Aerial cameras might be placed to detect any anomaly of smoke, or watch for things taking place in the manufacturing shop.

External antennas could be placed at power generating plants and in the lines to record changes in unusual demands. Personnel monitors could also be employed to detect shifts or fluctuations in the labor force.

Under the treaty, inspection teams would have to be allowed to come and go, Chase said, "and here we're concerned with the export of this is needed."

Accidents, too, would check factory records concerning disappearance of air materials, inventory of parts and changes in personnel. Engineers would check design looking for modifications or possibility of modifications that could signal an intention to violate the treaty.

In monitoring undedicated facilities such as highway, radio, cable and air routes, the problem becomes more difficult, Chase said.

For monitoring transportation, rail and highway existing rail weighing devices would have to be modified. In addition, weighlights with transmitters in trucks and inspection of transportation records such as bills of lading, and cargo manifests would have to be carried out to detect any irregularities in the flow of traffic.

One of the principal problems here is the "air corridor" traffic pattern between the U.S. and the Soviet Union, Chase said. In the USSR, the secret is an air transportation system in the U.S. it is highway transportation.

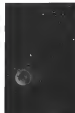
A comparison of available transport routes indicates that Los Angeles and Moscow illustrate this point. "If a cargo 390 is in direction west down around Moscow approximately 22 cargo loads, 12 railroads and four large cargo would be loading onto the cars."

A 40-ton freight train from Los Angeles would be loaded for about 15 cargo loads five railroads, and no cargo at all though there is a cargo route.

## Transportation Monitor

Detroit on the other hand has about 65 major roads intersecting an average cargo 30 in in direction toward the city. On a scale of three, Chase said, a comparable U.S. city will have on the order of 30-40 more major secondary roads leading into a city than Moscow, making the number and placement of transportation monitors a major problem.

An transportation is the one area monitored aspect of the transportation picture, Chase said. Here both the U.S. and the USSR operate under the same ground rules. In both countries ship-



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Continued on next page of this advertisement  
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## Westland Wessex Mk.2 Shown in Maiden Flight

First production Mk.2 Westland Wessex helicopter is shown on its maiden flight, flown by chief test pilot W. D. Stott from Westland Aircraft's Yeovil, England, production plant. The Vb. 2 Wessex is powered by two Bristol Siddeley Gnome free turbine engines and can carry 40 soldiers with equipment, or 14,000 lb. being externally. External changes from Wessex 1, adaptations of Sikorsky S-19, include single exhaust outlet on port side. Chas. Lawrence is RTV control and the ground crew has engine bay cooling. Riding on belly in gun blast under in perfect full taking which has been successful, extremely low rate of maintenance. Strong pilots the colored bands on: vital in four places, first two on below gun that is main knowledge. Helicopter is no production for Royal Air Force.



## CL-41A Flies With J85 Engine

First flight of a Lockheed CL-41A fitted with General Electric J85 turboprop engine took place recently. Other modifications on the aircraft are larger air intake and a cowling heat legs that save in air weight. Engines are being built under license by Donald Hughes, Ltd. CL-41A trainers also is being fitted with the J85. Original powerplant for the aircraft was the Pratt & Whitney JT12A.



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### Zeus Firing

Long Nike Zeus Missiles are in revenue model production now during second series of tests at Zeus test facility on Keesler field in the Pacific. Electronic control is made of responsive lightweight stylized and sleek the missile, while in its launch cell, from above a fighter.

units here to be brought to an airport where they could be operated by a specimen personnel on TV camera.

"There's no single pattern for a specimen," so one technique of development control, China, said. "The techniques will have to be used to use the conditions."

Boeing will handle the area control agency with a handbook list of possible items and a gross listing of about 2,000 items and processes used in missile and aircraft production. From these about 25-50 items will be identified to control items or processes.

Under the \$15,000 contract to develop production requirements, Boeing is conducting an extensive technical study to develop parameters that will have the U.S. and adequate recovery during any step-by-step development.

As part of this study, the University of Michigan is doing all possible ways

and means of ending both the spirit and the letter of a treaty. Boeing's problem will be to use these possibilities and to do this mathematically what requires a heavy violation.

Another problem is estimation of the level of simultaneous production taking place and how good the inspection system has to be to give an adequate picture of it. If we eventually, the amount will start again, if we underestimate it could produce an attack.

Boeing is working to establish parameters, which take into consideration the probably blue dawn into violation, the capability of the enemy to violate, and a case of how much destruction we could stand and still resist, to develop a counter area of tolerance for violations. Ideally, an inspection system developed should be good enough to serve as a deterrent, good national security and assure against violation, China said.

The Boeing studies are part of a larger pattern of ACDA disarmament research and study, grants which will eventually replace over 10% of the disarmament. Since 1961, ACDA's first year, expenditures for disarmament study is a sum from \$124,000 to \$400,000 for fiscal 1962 and \$1 million for 1963.

Whereas in fiscal 1962, contracts are grants must be about nine separate items, so far in fiscal 1963 about 32 contracts have been let in about five disarmament study areas. Study areas include maintaining a defense balance during disarmament, political aspects of disarmament, the interests of the U.S. in disarmament to other countries and our attitudes, general aspects of verification, how international organizations would handle disarmament and the economic impact of arms control including national budgeting.



### 727 Machmeter

Boeing 727 three jet transport will be fitted with the KMA 727 Machmeter designed by Smith Systems Division of Woodward-Clyde. Unit provided with integral lighting, maintains accuracy to 50,000 ft., and now is in quantity production for Boeing.

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## USAF and DOD Weapons Concepts Outlined at Ordnance Meeting

By Donald E. Fiat

New York—Air Force weapons programs, ranging from space flight to the development of improved weapons based on conventional explosives, were outlined here at the recent American Ordnance Association meeting.

Present was presented by Maj. Gen. Martin C. Dandridge, commander of Air Force Systems Command's recently created Research and Technology Division.

Four days of talks with the new weapons concepts:

- Delayed detonation tests with large tanks of propellant gas which had been shogged from space. The tanks exploded upon hitting the ground and spread their contents over several thousand square feet. A delayed fuse then ignited the whole area. Tests were aimed at proving the feasibility of producing high explosives with shapable, moldable, malleable.
- Weapons which use shaped charges to focus energy and destructive length. Power of conventional explosives is greatly magnified, under the force, can be directed. Tests also of tests on an F-30 target showed the aircraft disintegrated by a charge that normally would only inflict severe structural damage.

In the case of nuclear orbital flight and controlled, remote, Dandridge said, with the ASST-1 thermodynamic and structural test which has progressed through the testing stage. ASST-1 is aimed at releasing data on the lifting capacity of nuclear aerodynamic, thermal and structural data for the X-20A Distant Star program.

In an all-or-nothing vehicle, which has been tested, configurations involving the X-20A will be tested to glide trajectories at speeds up to 75,000 mph, at altitudes of 225,000 ft. They will glide for about 15 sec before they are released.

Part of the test is a bulky, nuclear control system, but this can be replaced with a control line to make some test systems as before flight. ASST-1 program should result in completion of data on lifting capacity, aerodynamic, thermal and structural data for the X-20A Distant Star flights. Dandridge said.

Part of the nuclear orbital flight program is the development of a spinning launch, orbital launch, and re-enters spaceflight. Called the Buteo, it consists of a disk with uniform data out as it rotates at high speeds the speedways concept and the disk appear to be transparent.

It is required on front of the spin view and a cooling gas is injected between it and the glass. During tests, the disk should maintain a temperature of 2,200° while the window remains only 310°.

This device would replace the solid jet, heatable window, which is proposed for the X-10A.

In the series of propulsion system programs, ranging from nuclear rocket engines to all-mineralizing, tests will be under development, Dandridge said.

Nuclear rocket programs has led to development and successful ground testing of Atomic Rocket Corporation's Tan 2A rocket at ARCC's Nevada Test Site.

An air-launched through the reactor at speeds reaching Mach 3 at sea level. Fuel element temperature during the tests was above 2,600° and the power level exceeded 150 million watts.

Tan 2A required approximately 600 lb. of air per second, while the 177 rocket, with maximum power output of about 11,000 lb. of thrust, requires less than 500 lb. of air per second.

Development of a Tan 2C reactor, a larger, air-cooled flight version, is entering its final phase and will conclude the nuclear rocket feasibility program.

Development of three types of nuclear gas is another area in which Dandridge and project is being made. These are aimed at solving problems in nuclear propulsion, caused by lack of stability in gas engines.

Three gas are:

- Nuclear gas, which is a complex, disordered, fluid, conventional, spinning, finite approach. It offers the possibility of precise velocity, orientation with no moving parts based on the nuclear magnetic resonance properties.

- Electronic gas, which exploits the properties of a solid state, spinning, finite approach. It offers the possibility of precise velocity, orientation with no moving parts based on the nuclear magnetic resonance properties.

• Atomic clock system for nuclear navigation which uses clocks accurate to one part in 10 to the twelfth power. Called Cetus propulsion system, using oscillations, the system will use one clock in the satellite and the other on the ground. Guidance information will be obtained directly by comparing the two clocks, changing the Doppler frequency change that takes place in receiving a signal from the ground to the satellite.

Defense Dept. member, Dr. John L. McManus, deputy director of Defense Research and Engineering, said, "We are interested in DOD's test concepts are





## ELECTROMAGNETIC WINDOWS

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Douglas is engaged in an intensive program to further development of radomes and antennas that will operate with precision in high performance missile and re-entry vehicle applications.

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Significance of this research is emphasized by the mechanical and electrical inadequacy of fiberoptics at the temperature levels of high-speed technology.



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## WHO'S WHERE

(Continued from page 21)

### Honors and Elections

Dr. Wilbur Cross, vice president of Licensing Division of Aero Corp., has been elected president of the Aviation Section, and Manufacturing Section, including George E. Gahagan, vice president of Van Dusen Aircraft Supply, Inc. Ben Brocken, Pacific Aerospace Corp., and J. R. Chubb, A. C. Spark Plug Division of General Motors Corp. elected vice president of ASEE.

James T. Deane, manager of technical studies and graduate engineering for General Electric Co.'s Direct-Current Motors and Generators Department, has been named the winner "Outstanding Young Electrical Engineer of the Year" for The IEEE. He has been acknowledged as design development and engineering talent in research and development projects.

### Changes

John H. Wilkin, director of research, Chrysler Aircraft Industries, Birmingham, Ill., and Jerome S. Goldwasser, staff engineer in planning for the new president-elect, resigning. Also, William H. Haddock, administrative manager of the Pacific Island Corporation Division, Berkeley, Calif.

Kenneth H. DeWitt, director of research, D. C. representative for the Society for the Advancement of Technology, Inc., New York, N.Y.

W. R. Casper, engineering manager, Technical Sales and Service Department, Cherry Road, Irvine, Calif., and J. R. Chubb, A. C. Spark Plug Division of General Motors Corp., San Francisco, Calif.

Dr. Roy Scott, director of research, has joined the staff of Lockheed Corp., San Jose, Calif.

Donald J. Black, director of the newly established Engineering and Development Department, Aero Corp., Aerospace Research Division, Northridge, Calif.

W. J. Conley, Jr., manager, Noctua (Nuc) plant at Hawthorne, a division of North American Aviation, Inc., succeeding E. A. Wright, now, assistant general manager of the company's Space Engine Plant and Operations, Canoga Park, Calif.

Robert J. Knecht, director of research, has joined the staff of Lockheed Corp., San Jose, Calif.

Col. John S. Vance (USAF, ret.) has joined Aerojet-General Corp., Azusa, Calif., as a corporate specialist in personnel and training.

Elmer Nelson, director of research, Space Systems, Co. Ltd., Bristol, England, and Peter A. Houghton, manager, Test-Cent Facilities Group.

Col. Russell E. Schick (USAF, ret.), executive advisor to Douglas Aircraft Division's Advanced Systems and Research Department, Long Beach, Calif.

Dr. Samuel E. Eubank, director, Office of Research, Aerospace Corp.'s San Ramon, Calif. Operations.

Richard W. Powell, associate director, Aerojet-General Corp.'s Supersonic Division, Azusa, Calif.

## Anti-Submarine Warfare

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Will engage in the analysis of weapons systems. Applicants must be specialists in operations research or have extensive experience as weapons systems engineers.

### APPLIED RESEARCH

Must have extensive experience in any of these fields: propagation, matched filter theory, pattern recognition, statistical communication theory, underwater communications, statistical decision theory.

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## "IN-SERVICE" ENGINEERS ROME AIR MATERIEL AREA (AFLC)

Rome Air Materiel Area has been assigned the mission of providing Ground Communications-Electronic logistic support to the Air Force. A very vital facet for fulfilling this responsibility involves those engineering functions necessary to insure the performance integrity of the C-E equipments and systems once they become operational.

### TYPICAL RESPONSIBILITIES OF ROAMA "IN-SERVICE ENGINEERS" ARE:

Modification or rehabilitation of operational Ground C&E equipments by correction of design deficiencies.

Development of engineering specifications for support of procurement.

Providing engineering design criteria to insure maintainability, serviceability and reliability of operational C&E equipment.

Performing engineering liaison with AF Contractors.

CURRENT AND FUTURE ASSIGNMENTS CREATE AN EVER INCREASING DEMAND FOR:

Electronic Engineers (all disciplines)  
Electrical Engineers

Mechanical Engineers  
General Engineers

TO MONITOR AND PERFORM WORK ON VITAL PROJECTS IN THE FOLLOWING AREAS:

Search and Detection Radar

Missile Guidance and Tracking

Digital and Analog Computers

Detection and Identification Equipments

ICBM Communications Sub-Systems

Communications Auxiliary Equipments

Electronics Systems (Warning, Intelligence, Command, Support etc.)

We have an immediate and urgent need for Graduate engineers to insure the operational readiness of Ground C-E systems and equipments. Current demands at Rome Air Materiel Area for in-service engineering support are heavy. Increased mission responsibilities will entail even heavier demands in the future.

ROAMA's Directorate of Material Management provides an immediate career opportunity for graduate Electronic, Electrical, General and Mechanical Engineers. Ground Communications and operational Electronics Systems and Equipments are subject to continuous change consistent with advances in the state of the art.

For more information about Air Force civilian career opportunities in "In-Service" Engineering submit your resume to:

Mr. William Pogue  
Professional & Scientific Recruiter  
ROAMA  
Coffey Air Force Base,  
Rome, New York



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Long a world leader in helicopters, we are expanding strongly into vertical-lift systems of VTOL application. And we need men who can accept this opportunity to give us their help build tomorrow's leading-edge future aircraft. Some indication of what tomorrow holds can be gained by the many jobs being performed by Sikorsky VTOL system today. Typical of our diversity are such current projects as space capsule recovery, a new submarine system, a transport and personnel transport, a rescue mission, a support passenger liner, a medical transport and personnel transportation. It's a new and exciting job—one which holds bright promise for the outcome engineers who can match their growth to ours.

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### Academic advancement

Further advancing our staff professional advancement is the opportunity we offer engineers to earn advanced degrees through a co-sponsored Graduate Education Program. These programs are available at such excellent schools as Yale University, Brown University, Polytechnic Institute (Shoreland Graduate Center), and Columbia University.

You are invited to send your resume in confidence during salary negotiations to Mr. Leo J. Shalvey, Personnel Department.

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## SATURN S-IVB...

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The Saturn S-IVB stage is a key element in the U.S. Manned Lunar Program. An S-IVB vehicle will be used to thrust the manned Apollo spacecraft into earth escape trajectory to the vicinity of the moon. Apollo's first orbital and re-entry tests will utilize the S-IVB vehicle prior to the final development of the Saturn C-5 Launch Vehicle.



### PROPULSION

The lunar mission of the S-IVB depends on the use of high performance cryogenic propellants in a main propulsion system capable of engine start at a stage separation and re-start in orbit for the Apollo escape. Altitude control during ascent and descent requires a positive explosion abortable propellant system for instant abort upon under zero gravity. Propulsion requirements on S-IVB demand advanced design concepts in automatic checkout, modular pneumatic and propellant components, positive explosion devices, and zero systems.

Designs to unique propulsion specialists who can meet the Saturn S-IVB challenge in initial design, hardware design, and development tests. Send your resume to Mr. W. C. Ames, Saturn S-IVB Recruitment Director, Douglas Missile and Space Systems Division, Dept. 411, 3000 Center Park Boulevard, Santa Monica, California.



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## RENDEZVOUS CONTROL: *By Astronaut*

DEC. 19 1967

Primary control responsibilities during Gemini rendezvous and docking operations will be assigned to the Astronauts. Man, with his ability to see, analyze, reason and judge, will be fully utilized for this important phase of America's first spacecraft rendezvous operation.

Gemini is a two man, extended mission, orbital rendezvous and docking spacecraft now being designed and built for the National Aeronautics and Space Administration by McDonnell.

Rendezvous in space can have several applications

in speeding America's space exploration efforts. Rendezvous will permit launching of multiple payloads with two or more smaller boosters rather than one large vehicle. With such techniques it will be possible to assemble large space stations, ferry space crews and supplies, refuel and/or assemble chemical upper stages for deep space missions, and refuel re-usable nuclear upper stages for deeper space explorations.

Space Rendezvous, the key to a quickened pace in manned space exploration, is another facet of manned space flight being pioneered by McDonnell.

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